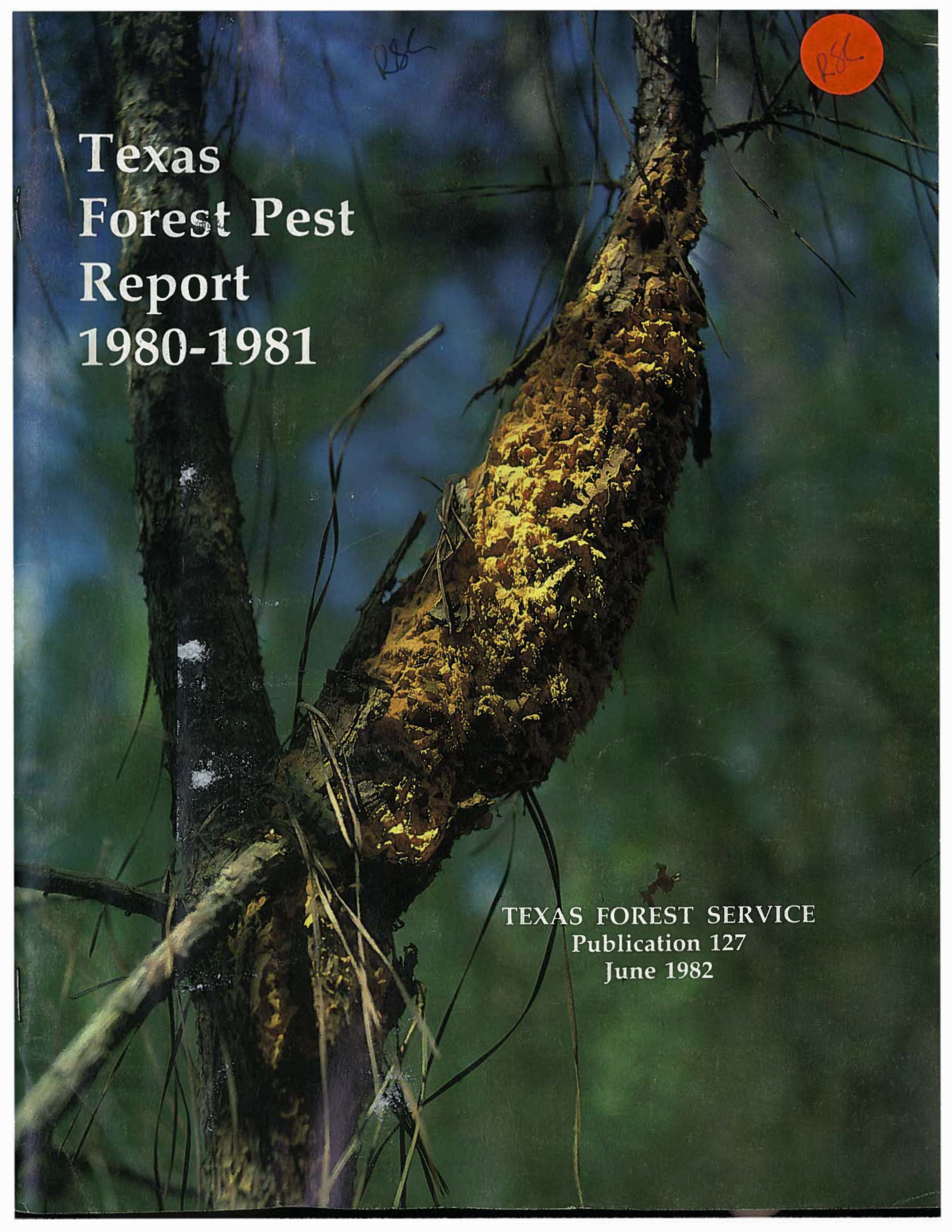




Texas Forest Pest Report 1980-1981

TEXAS FOREST SERVICE
Publication 127
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1980 - 1981 Highlights

- Southern pine beetle activity remained at low levels throughout East Texas; outbreaks of the black-headed pine sawfly occurred near Bastrop and Conroe in 1981.
- A 1980 survey of young pine plantations in southeast Texas shows that the level of fusiform rust infection has increased dramatically in recent years.
- Insecticides were applied from the air to Texas Forest Service pine seed orchards for the first time in 1981.
- Pydrin®* - a new insecticide - is now available for cone and seed insect control in pine seed orchards. Pydrin is registered for both aerial and ground applications.
- A long-term project has been established in Polk and Tyler counties to demonstrate new approaches for the integrated management of southern pine beetle and related pests.
- A 1981 poll of foresters documents the relative importance of forest pest problems and the contributions of forest protection programs in East Texas.

KEY WORDS:

forest insects, forest diseases, southern pine beetle, seed orchard insects, pine sawflies, fusiform rust, oak wilt, pheromones, insect traps, forest protection, insect damage.

COVER PHOTO:

Sporulating fusiform rust canker. The severity of fusiform rust infections have increased markedly in southeast Texas, particularly in young slash pine plantations. Photo by R. F. Billings.

*

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Texas Forest Pest Activity
1980-1981
and
Forest Pest Control Section
Biennial Report

With Cooperation From
Private Forest Industry
and
National Forests in Texas

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INTRODUCTION

Since its establishment in 1963, the Forest Pest Control Section of the Texas Forest Service has provided information, guidance and technical assistance to practicing foresters and major forest landholders in all matters dealing with forest pests. The Section is responsible for monitoring pest activity on 12 million acres of state and private forest lands in East Texas. The Section also conducts applied research on major insect and disease pests of pine seed orchards, plantations and natural forest stands. Every two years, the Section prepares a biennial report to document recent pest problems and the damage they have caused to East

Texas forest resources. This report includes a synopsis of research accomplishments and recent developments involving the Pest Control Section. In this issue we publish the complete results of a 1981 poll of foresters' opinions concerning forest insect and disease problems and forest protection programs in East Texas. This survey was sponsored by the Forest Pest Subcommittee of the Texas Forestry Association. Much of the information on 1980-1981 pest activity and damage has been provided by foresters with the Texas Forest Service, private forest industry and the National Forests in Texas. Their contributions are gratefully acknowledged.

TEXAS FOREST PEST ACTIVITY

1980-1981

SOUTHERN PINE BEETLE

Populations of the southern pine beetle (*Dendroctonus frontalis*) generally decreased across the South during 1980. Five states (Georgia, Alabama, Mississippi, North Carolina and South Carolina) had federally-funded southern pine beetle (SPB) suppression projects. In most areas more than half of the beetle-killed

timber was salvaged.

By the summer of 1981, SPB activity in the South had declined to low levels. Texas, Oklahoma, Arkansas and Louisiana reported no confirmed infestations, while Alabama, Mississippi, Georgia, North Carolina and South Carolina reported only a few, small spots. It is uncommon to find SPB activity at low levels all across the South in a given year.



Figure 1. Devastation caused by the southern pine beetle during the most recent outbreak can still be seen six years later in undisturbed areas of East Texas. Beech Creek Unit, Big Thicket Biological Preserve, Tyler County, Texas.

The southern pine beetle has remained at low levels in East Texas since the most recent outbreak collapsed in the summer of 1977 (Figure 1). Only two small SPB spots were reported in East Texas in 1980 -- one spot in Montgomery County and a

second in Trinity County. Two cords and 55 MBF of timber were killed with 50 MBF salvaged. For the first time since the mid-1950's, no confirmed SPB spots were reported in Texas during 1981.

PINE SAWFLIES

The black-headed pine sawfly (*Neodiprion excitans*) reached outbreak levels in local areas of East Texas during 1981 (Figure 2). This pine defoliator has been scarce in recent years but outbreaks are known to occur periodically. In the fall of 1958, this sawfly defoliated 25,000 acres of loblolly and shortleaf pine in southeast Texas. The outbreak continued into 1959 and in the summer of that year 17,000 acres of sawfly infestation were sprayed from the air with DDT.

occurred in Bastrop, Fayette, Montgomery and Walker counties. The defoliation was first noticed on a few trees in Bastrop County in the fall of 1980. By early May 1981, this sawfly had partially defoliated most of the pines in the southern half of Bastrop County. The spring generation completed pupation by the third week of May. At the end of May adult sawflies were numerous and were mating and ovipositing on loblolly pine foliage. At this time a large second generation was anticipated.

The 1981 outbreak primarily

We noted that the female sawflies



Figure 2. *Black-headed pine sawfly:* A) female ovipositing on pine needle, B) cluster of larvae feeding on pine foliage, C) pupal cases and newly-emerged adults, and D) pine defoliated in Bastrop County, Texas.

were laying eggs primarily on trees that had not been heavily defoliated by the first generation of larvae. Egg laying also was noticed in areas north of the Colorado River in Bastrop County -- evidence that the area of activity was moving north. In some areas, pupal parasites were numerous.

By late June, pine defoliation was present over most of the remaining pine range in Bastrop County that had not been defoliated by the first sawfly generation. Larval populations were extremely high, but they were exhibiting strange behavior. With foliage still on the trees and larval development not yet complete, the sawflies stopped feeding and began to wander. It was not uncommon to see large branches and the trunks of some trees completely covered with masses of larvae. At the same time, we found large numbers of dead larvae at the base of trees. These observations provided evidence that the outbreak was being contained by natural factors, possibly a virus disease.

By mid-July no live black-headed pine sawfly larvae or pupae could be found in any of the "Lost Pines" area of Bastrop and surrounding counties. Literally piles of dried and shriveled larvae had accumulated at the bases of trees. The outbreak had apparently collapsed.

By late summer most of the pine trees in the Lost Pines area had thin crowns indicating light to moderate defoliation. Very few trees were heavily defoliated. The sawfly larvae had fed mainly on the older needles leaving the current year's growth intact. Few trees died as a direct result of the sawfly defoliation. However, some severely weakened trees were eventually attacked and killed by bark beetles. It is expected that most of the trees will recover during the 1982 growing season.

A second outbreak of black-headed pine sawfly was observed in

and around Montgomery County from August to November 1981. This insect is not expected to have an economic impact on the pine forests in the area. However, some large sawtimber trees were severely defoliated and may become susceptible to bark beetle attack in the spring and summer of 1982.

Scattered and localized infestations of red-headed pine sawfly (*Neodiprion lecontei*) were reported in Leon, Houston, Sabine and Shelby counties in 1980, and in Rusk County in 1981. The defoliation was not severe and the trees recovered.

TOWN ANTS

Colonies of the Texas leaf-cutting ant or town ant (*Atta texana*) have continued to cause concern when they occur near newly planted pine trees. Of all the pest problems reported during 1980 and 1981, town ants were the most numerous. Reports of damage were received from all areas of East Texas. The ants commonly remove all needles and buds, often killing the seedlings. By foraging up to 300 feet from the town for green vegetation, the ants may cause an economic impact over 5-15 acres. They prefer deep, sandy soils which abound over much of East Texas.

At present, control for town ants is limited primarily to fumigation with methyl bromide. This chemical is effective, but somewhat time-consuming to apply. Also, methyl bromide is a restricted use pesticide, available for use only under the supervision of certified pesticide applicators.

An insecticide bait that is safer to apply than methyl bromide, possibly one that could be broadcast over the town to control the ants, is needed. The Pest Control Section is currently evaluating a bait developed for fire ants with the goal of finding an effective alternative to methyl bromide.

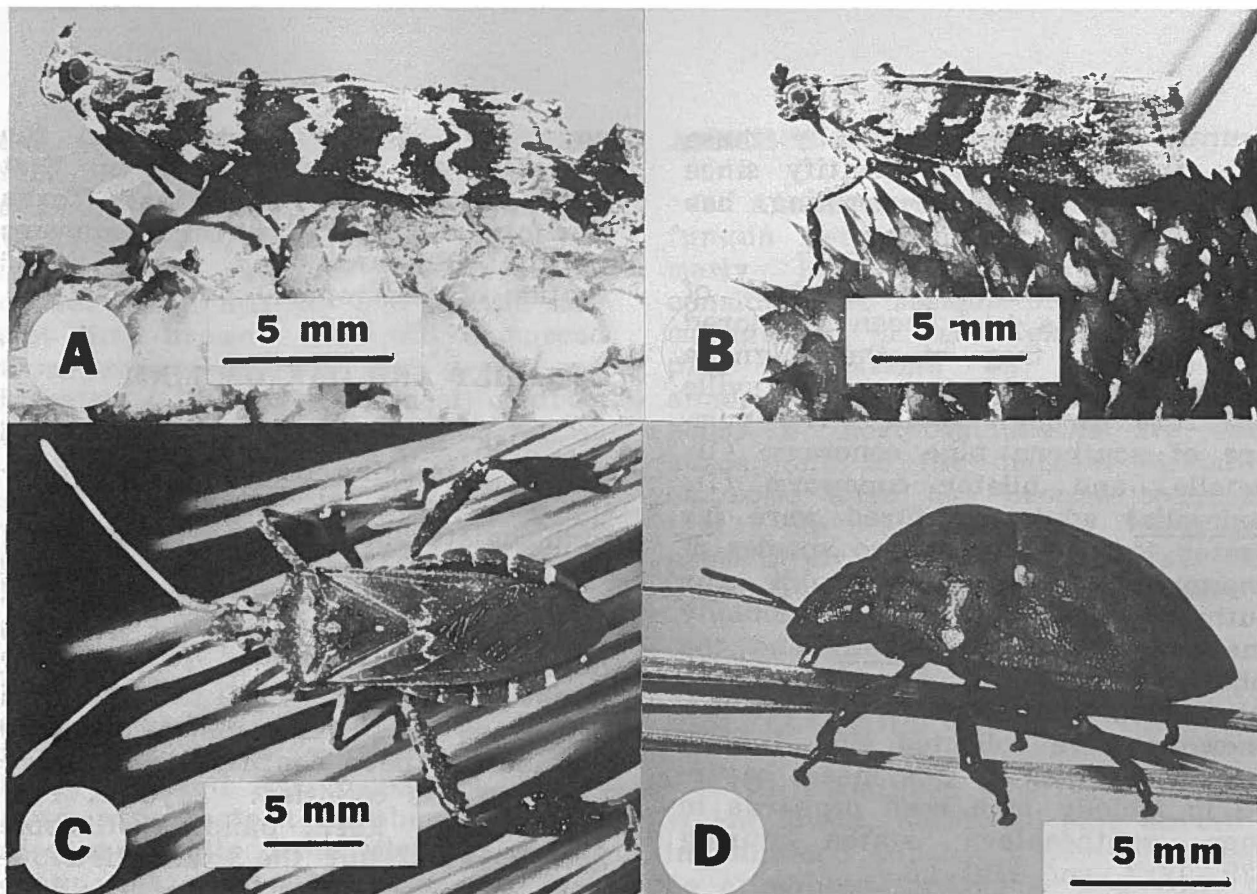


Figure 3. Important pests in southern pine seed orchards: A) Dioryctria amatella, B) Dioryctria clarioralis, C) Leptoglossus corculus, and D) Tetyra bipunctata.

GYPSY MOTH IN TEXAS?

The gypsy moth (Lymantria dispar) was introduced into the United States from Europe in 1869. Since then, it has become one of the biggest forest pest problems in the Northeast. Oaks are the preferred host of this insect, but many other species of trees and shrubs may be defoliated during outbreaks. Repeated defoliation often causes tree mortality. Large numbers of larvae and their droppings are a nuisance in recreational or populated areas.

The potential for spread of gypsy moth is extremely high due to the extensive range of host material. Egg masses are easily transported on recreational vehicles, nursery stock and forest products. Gypsy moth populations have been established or male moths have been trapped in several states (Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Washington, and others) outside the moth's normal geographical range.

An established infestation of gypsy moth was discovered in Fulton County in northern Arkansas in the summer of 1981. The infestation was traced back to a camper trailer which was moved from Rhode Island to Arkansas in the spring of 1977. Although gypsy moths have yet to be detected in Texas, the threat of spread to this state is real. The potential for eventual establishment in Texas is favored by the large acreages of hardwood forests and the location of numerous recreation sites in these wooded areas. Pest Control entomologists are keeping alert for the presence of this insect pest in Texas.

SEED AND CONE INSECTS

Coneworms (Dioryctria spp.) and seed bugs (the leaffooted pine seed bug, Leptoglossus corculus, and the shieldback pine seed bug, Tetyra bipunctata) are the key insect pests in southern pine seed orchards (Figure 3). Population levels and

amounts of damage caused by these pests are difficult to quantify since only minimal periodic sampling has been conducted.

The seasonal flight periods of coneworm moths have been monitored with a light trap at the Magnolia Springs seed orchard near Kirbyville from 1978 through 1981. The numbers of southern pine coneworm (D. amatella) and blister coneworm (D. clarioralis) adults captured were far greater than the other two species of coneworms known to inhabit the southern pines in Texas - the loblolly pine coneworm (D. merkei) and the webbing coneworm (D. disclusa). Only a few specimens of the webbing coneworm were collected even though a major outbreak of this insect occurred in loblolly pine seed orchards in other southeastern states during 1979, 1980, and 1981.

The numbers of coneworm moths captured in the light trap were somewhat smaller during 1980 and 1981 than in 1979. Coneworm damage among cones harvested from loblolly orchards in 1981 ranged from 5 to 12%. Low to moderate leaf-footed pine seed bug populations were observed during 1980 and 1981 in TFS seed orchards. Only a few shieldback pine seed bugs were observed in loblolly pine seed orchards in 1980, but in 1981 the population built up to the highest level in the past six years. Between 3 and 13% of the seeds in cones harvested from loblolly orchards in 1981 were damaged by seed bugs. Most of this damage was attributed to shieldback pine seed bugs since leaf-footed pine seed bugs were relatively scarce at cone harvest in 1981.

FUSIFORM RUST

Fusiform rust (Cronartium quercuum f. sp. fusiforme) is present on slash and loblolly pine in all areas of East Texas (see front cover). However, infections are most severe in southeast Texas, particularly in Hardin, Jasper, Newton, Polk and Tyler

counties. For more details on the severity of fusiform rust in East Texas, refer to the "East Texas Fusiform Rust Survey" that appears in the "Research and Applications" section of this report.

OAK WILT AND OAK DECLINE

Oak mortality in central Texas caused increasing public concern during 1980 and 1981. For many years pathologists believed that oak wilt would not occur in Texas because the fungus cannot survive high temperatures (the fungus can only live two hours at 90 degrees F.). In 1961, however, oak wilt was isolated from oak trees in Dallas. Since then the disease has been confirmed in the following Texas counties: Fayette, Travis, Blanco, Kerr, Bandera, Gillespie and Bexar. But the exact distribution of oak wilt in Texas is not known.

Oak wilt, caused by the fungus Ceratocystis fagacearum, appears to be the main cause of oak mortality in central Texas. Oak wilt usually causes the tree to die in four to six weeks; however, it may take several years to completely kill the tree. Live oak and Spanish or Mexican oak seem to be the most severely affected, although other oaks may be hosts. Post oak, a common tree species in many areas of Texas, is tolerant to oak wilt.

Initial symptoms of oak wilt are leaf browning, chlorosis and premature leaf drop. Trees often die quickly after initial symptoms appear. Advanced symptoms include twig and branch dieback, small leaves, thin crowns and adventitious sprouts on the trunk and large limbs. The initial symptoms usually develop rapidly in healthy trees, mostly during the spring and fall. Trees that die rapidly usually retain the dead brown leaves for a period of time after the tree dies.

Leaf symptoms of oak wilt on live

oak are very characteristic and provide the best field identification available. When the mid-rib and veins of the leaves turn yellow or brown, oak wilt is the probable cause. The leaf tip and margin may also turn brown. Oak wilt is spread from tree to tree by root grafts and insects. Effective chemical controls have not been developed.

Another tree disease occurring over a large area of Texas is commonly called oak decline. This disease, caused by the fungus Cephalosporium diospyri, is known to affect several tree species including live oak, post oak, water oak, Spanish oak, black-jack oak, willow oak, pecan, hackberry, winged elm, persimmon, sycamore and western soapberry. This disease results in a dieback of the crown that generally increases each year, eventually resulting in the tree's death. It may take from five to twenty years for a large live oak to die.

Usually the first visible symptom of oak decline is a thinning of the crown of the tree due to branch dieback and smaller than normal leaves. As the dieback progresses, sucker growth will develop on the larger limbs and trunk giving the tree a stunted or stubby appearance. Leaf symptoms are not always present, but when they are, the distal half of the leaf (or the lobes of lobed leaves) will be tan or reddish brown. Brown streaks may be present in the sapwood of branches or small limbs.

Oak wilt and oak decline can resemble other tree problems such as those caused by construction damage, gas injury, herbicide damage, salt accumulation and the like. Because of this, laboratory cultures of tree tissue samples are the only way to positively identify the presence of oak wilt or oak decline. Considerable research is being conducted on both diseases, and hopefully, more effective and less expensive controls will be found in the future.

ANNOSUS ROOT ROT

Annosus root rot caused by the fungus Heterobasidion annosum (formerly Fomes annosus) has not been considered a serious problem in pine management in East Texas. Thinned pine plantations on high hazard annosus sites (generally deep, sandy soils) in northeast Texas are most susceptible to the disease. Mortality on some sites has become so great that the stands are harvested prematurely or thinned at an unscheduled time to minimize losses.

MISCELLANEOUS PESTS

With southern pine beetle activity at low levels, nearly all pine mortality in pulpwood and sawtimber stands can be attributed directly or indirectly to Ips engraver beetles (Ips avulsus, I. calligraphus, I. grandicollis) or the black turpentine beetle (Dendroctonus terebrans). These insects occur at various concentrations throughout the pine forests of East Texas each year. Trees that are weakened, damaged or stressed for whatever reason are more susceptible to attack by these bark beetles. Almost every county in East Texas reported pine mortality due to these insects during 1980 and 1981. All reported spots were small and scattered.

Many young loblolly and shortleaf pines in East Texas are attacked each year by the Nantucket pine tip moth (Rhyacionia frustrana). These insects rarely kill a tree, but heavy infestations can cause reduced growth and a "branchy" tree. Significant tip moth activity during the summer of 1980 was reported in northeast Texas, particularly Camp, Franklin, Morris, Titus, Upshur, and Wood counties. In some areas, trees 25 to 30 feet tall were attacked. Severe tip moth damage also was reported in a pine plantation in Liberty County. No significant tip moth activity was reported for 1981.

The pine colaspis beetle (Colaspis pini) occurs periodically in localized areas of East Texas. During June 1981 some colaspis beetle feeding was noted in Tarkington Prairie in Liberty County. These insects are not a serious pest of pines, but their feeding causes a spectacular browning effect of the needles similar to fire scorch. The adults resemble brown, striped lady bird beetles. Attacked pines recover in time and little if any growth loss occurs.

During the winter of 1980-1981 Pest Control entomologists were asked to evaluate insect activity in a sawtimber-sized stand of loblolly pine that had recently been prescribed burned in Houston County. A forester had noticed fine, red sawdust on the trunks of the heavily charred trees and assumed it was caused by

Ips engraver beetles. Upon examining the trees, we found that powder post beetles (Bostrichidae) rather than Ips were boring in the charred bark. Since these beetles were not feeding in the cambium, there was no damage to the tree and control was not needed. Similar powder post beetle feeding was observed in charred pine bark in Wood and Montgomery counties.

Pine webworm (Tetrolopha robustella) damaged 60 acres of young pine in Shelby County. This pest is always present in East Texas, but seldom causes economic damage.

Rabbits were abundant during the winter of 1980-1981 and reportedly destroyed 1000 acres and heavily damaged an additional 320 acres of pine seedlings in Nacogdoches County.

NEW PEST MANAGEMENT APPROACHES

A major responsibility of the Forest Pest Control Section is to evaluate and encourage the implementation of new strategies for protecting Texas forest resources from insect and disease pests. During 1980 and 1981, new approaches to pest management have been initiated in pine seed orchards for cone and seed insect pests and in natural forest stands for southern pine beetle and related pests. Also, a survey of young loblolly and slash pine plantations was conducted to document the current level of fusiform rust infection.

PINE SEED ORCHARD APPLICATIONS

To meet increasing demands for high quality pine seed for reforestation programs in East Texas, seed orchards have been established from parent trees genetically selected for outstanding characteristics of growth, form drought hardiness or disease resistance. Throughout the nearly two year period of seed development, pine cones must be

protected from a variety of destructive agents, including cone and seed insect pest. Recent advancements in seed orchard protection methods include the registration of a new insecticide and improved methods of insecticide applications in pine seed orchards.

Registration of a New Insecticide -- Pydrin®

In recent years two insecticides, Furadan® and Guthion®, have been used extensively to control insect pests in southern pine seed orchards. A third insecticide, Pydrin®, is now available for the control of pine coneworms and seed bugs. Pydrin was registered for this use in October 1981, by the Environmental Protection Agency (EPA). This new registration resulted from the cooperative efforts of many scientists, technicians and seed orchard managers across the South. The Pest Control Section contributed in this effort by testing Pydrin in a loblolly pine seed orchard at Magnolia Springs during 1979 (Texas Forest

Furadan and Guthion belong to well known groups of insecticides called the carbamates and organophosphates, respectively. Pydrin belongs to a relatively new group of compounds known as synthetic pyrethroids. Pydrin is a comparatively safe material to handle; its mammalian oral toxicity is considerably lower than that of Furadan and Guthion.

In field tests leading to registration, Pydrin was generally as effective as Guthion in controlling cone and seed insect pests. However, according to the new label, the amount of Pydrin used in southern pine seed orchards is not to exceed 2.4 pounds of active ingredient per acre per year.

This limits the number of times an orchard can be treated with Pydrin each year to three aerial sprays or two to three ground sprays, depending on tree size. Supplemental applications of Guthion therefore are required to provide optimal insect control.

Ambush®, another synthetic pyrethroid, and Imidan®, an organophosphate insecticide, also were tested recently in southern pine seed orchards. EPA registration of these insecticides for control of cone and seed insects is expected soon.

Aerial Applications of Insecticides

In recent years, insect control programs in Texas Forest Service pine seed orchards have included one application of Furadan in some production orchards and four to five applications of Guthion applied from the ground in other orchards. In tests conducted in 1980, the Span Spray mist blower used to apply Guthion did not provide adequate spray coverage

in the tops of large seed orchard trees. Experiments conducted by the USDA Forest Service have shown that Guthion applied by fixed-wing aircraft or helicopter can provide good control of cone and seed insect pests. Aerial application of insecticides in seed orchards has several advantages over ground application. Aerial sprays are directed into the tops of trees where most cones are located, thus providing for better utilization of the pesticide. Less insecticide material is used in aerial spray applications, thus reducing treatment costs. Furthermore, aerial treatments are rapid and can be more easily applied during optimal weather conditions and better timed to coincide with vulnerable stages of key insect pests. Finally, exposure of seed orchard workers to toxic pesticides is reduced by contracting an aerial applicator to do the job as compared to ground applications.

Because of these advantages, an aerial applicator was contracted in 1981 to treat two Texas Forest Service loblolly pine seed orchards totalling 40 acres at Magnolia Springs. A fixed-wing aircraft was used to apply Guthion on April 29, June 8, July 10, and August 10. Strips of water sensitive paper were distributed on the ground around the spray blocks before each spray to monitor the spray drift. Cards wrapped around beverage cans were suspended in the upper half of the crowns of selected trees in the spray areas to monitor spray coverage. Very little drift was detected on cards distributed outside the immediate treatment area during each spray application. The intensity of spray droplets on cards suspended in trees in treatment areas was generally adequate. But only about 50% of the area on most cards was covered with droplets, possibly suggesting a need for improved coverage.

The effectiveness of these insecticide treatments was evaluated by analyzing ten randomly-selected

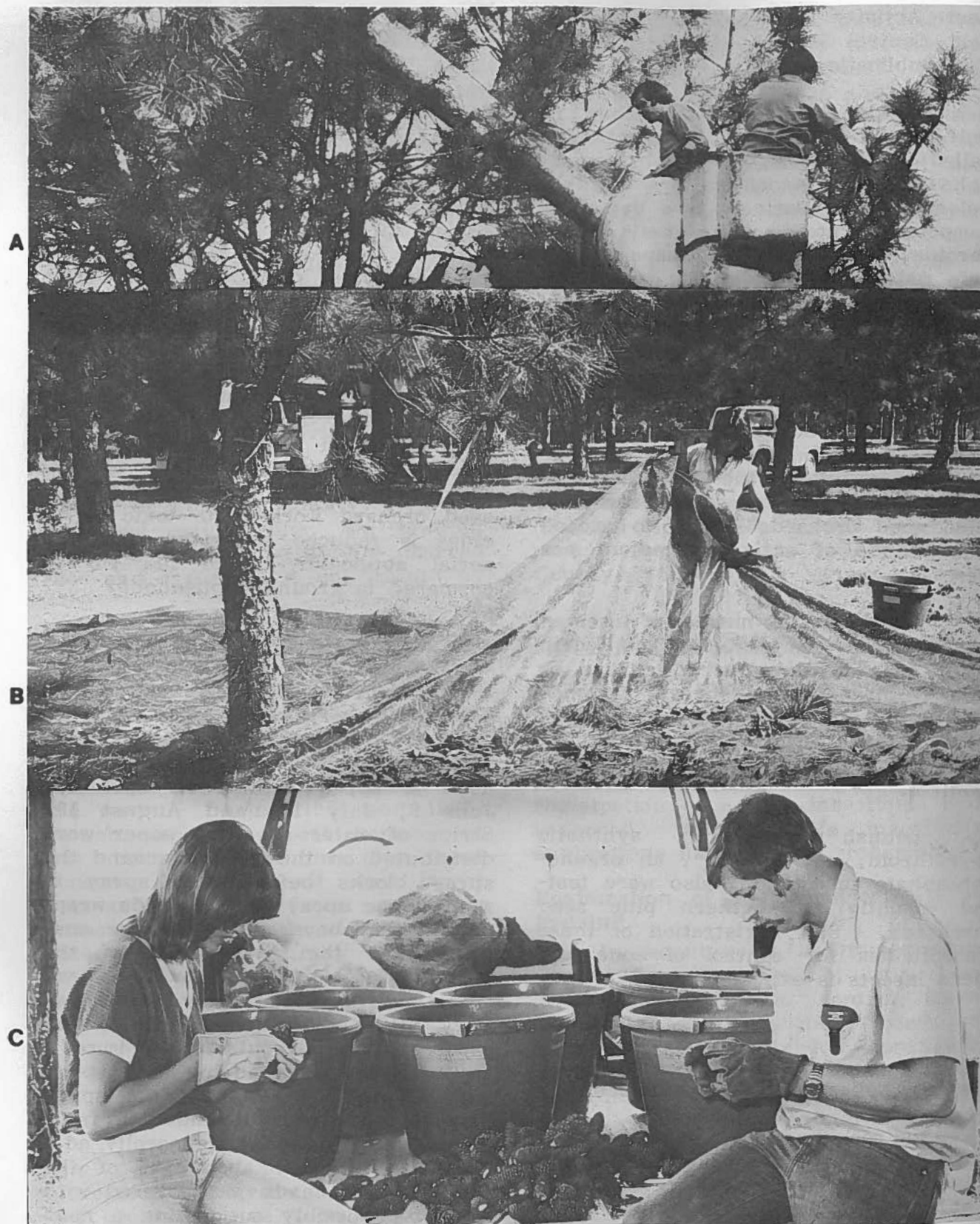


Figure 4. Evaluation of insecticide spray schedules in a loblolly pine seed orchard at Magnolia Springs, Texas: A) Pest Control personnel selectively harvest cones from a treated tree, B) harvested cones are collected from netting at base of tree, and C) technicians Carol Riggs and Alan Smith inspect cones for insect damage.

Table 1: Comparison of coneworm and seedbug damage by treatments in loblolly pine seed orchards at Magnolia Springs, TX. 1981.

Loblolly orchard	Treatment	Percent coneworm - damaged cones	Percent seedbug - damaged seed
174 Superior	Guthion (4 aerial applications)	4.9 ^a	7.2 N.S.
174 Superior	Furadan (1 soil application - February)	12.1 [*]	12.9 N.S.
082 Drought-hardy	Guthion (4 aerial applications)	6.6 N.S.	2.7 ^{**}
172 Drought-hardy	Check (no treatment)	10.5 N.S.	9.6 ^{**}

^a Means differ significantly (*p<0.05; **p<0.01) between treatments within orchards according to t-test.

bushels of cones from each of the following blocks: 1) superior loblolly treated with four aerial applications of Guthion 2) superior loblolly treated with Furadan in February 3) drought-hardy loblolly receiving four aerial applications of Guthion and 4) drought-hardy loblolly which received no insecticide treatments.

Pest Control technicians inspected cone samples (Figure 4) to determine the extent of insect damage. The seeds were extracted from 100 cones randomly selected from each bushel of sample cones and 500 seeds from each sample were subjected to X-ray analysis to determine seed quality.

Results (Table 1) suggest that coneworm and seed bug damage among cones harvested from orchards treated with four aerial applications of Guthion was generally less than half that in check orchards used for comparison. Unfortunately, due to wide variation among samples, not all of the observed differences proved to be statistically significant.

SOUTHERN PINE BEETLE DEMONSTRATION PROJECT

Goal

In recent years, considerable effort has been devoted southwide to research on the southern pine beetle (SPB). Research findings have contributed to our understanding of the beetle and its interaction with host trees, other organisms and the environment. This information is useful for developing improved methods of prevention and direct control.

Beginning in July 1980, the Pest Control Section established a demonstration area in Polk and Tyler counties. The basic goal of the project is to demonstrate new approaches for the integrated pest management (IPM) of bark beetles and related pests. We hope the demonstration efforts will facilitate rapid transfer of available new technology to field foresters and other land managers.

Initial project activities were aimed at soliciting the cooperation of

major forest industries in the area and gathering the necessary supplies and equipment. Progress to date has included 1) establishment of a landowner advisory board, 2) development of SPB hazard maps for all commercial pine stands in Polk and Tyler counties, 3) establishment and use of a computer system at Lufkin, 4) purchase of a portable sawmill for lease to private non-industrial landowners, and 5) transfer of new technology to field foresters.

Financial Support

Financial assistance is being provided by the USDA Forest Service program entitled, 'Integrated Pest Management for Bark Beetles of Southern Pines' and the Animal and Plant Health Inspection Service (APHIS), in cooperation with USDA Forest Service Southeastern Area State and Private Forestry.

Landowner Advisory Board

Representatives of forest industry (Champion International, Kirby Forest Industries, Owens-Illinois, St. Regis Paper Company, Temple-EasTex Forests, International Paper Company, and Wirt-Davis Estates) and the TFS Area IV forester were nominated to form a landowner advisory board. The board meets periodically with research and project management personnel from the TFS and Texas A&M University to review project accomplishments and to provide guidance on project activities. The landowner advisory board has been and will continue to be an important component of the IPM project. With industry cooperation and contribution, project activities can be directed to areas of actual, recognized need by the forestry community.

SPB Hazard Mapping

Research in recent years has

shown that certain pine stands are more prone to SPB attack than others. Site and stand factors associated with SPB infestations include high pine density (basal area per acre), large-sized trees and bottom-land sites (Figure 5A). Methods for hazard rating pine stands based on these factors were used to develop SPB hazard maps for all commercial pine stands in the demonstration area (1,100,000 acres). Stand data were obtained from recent color infrared aerial photographs (Figure 5B), while landform classifications were taken from topographic maps. Copies of the final hazard maps (scale 1" = 2000') are being provided to the major industrial landowners (Figure 5C). Industry is encouraged to use this hazard information to monitor highly susceptible stands and to thin or harvest these stands when practical. The industrial landowners also have been asked to provide follow-up information regarding the status and treatment of these stands.

Many of the high and extreme hazard stands are located on non-industrial private ownerships. These landowners are being contacted on a person-to-person basis by TFS foresters. The landowner is informed about the presence of beetle-susceptible pine stands on his property and encouraged to reduce that hazard by thinning or harvesting the stand. Some assistance may be provided for marking the stand for thinning. Practical information on SPB hazard rating, prevention, and control is being distributed to the non-industrial landowner.

Computer System to Aid IPM

In January 1981 a computer system composed of an Apple III (128K) microcomputer (Figure 5D) and an Anadex 9500 printer was installed at the Pest Control lab. Since that time the microcomputer has been used for a variety of tasks. Programs developed by Pest Control personnel

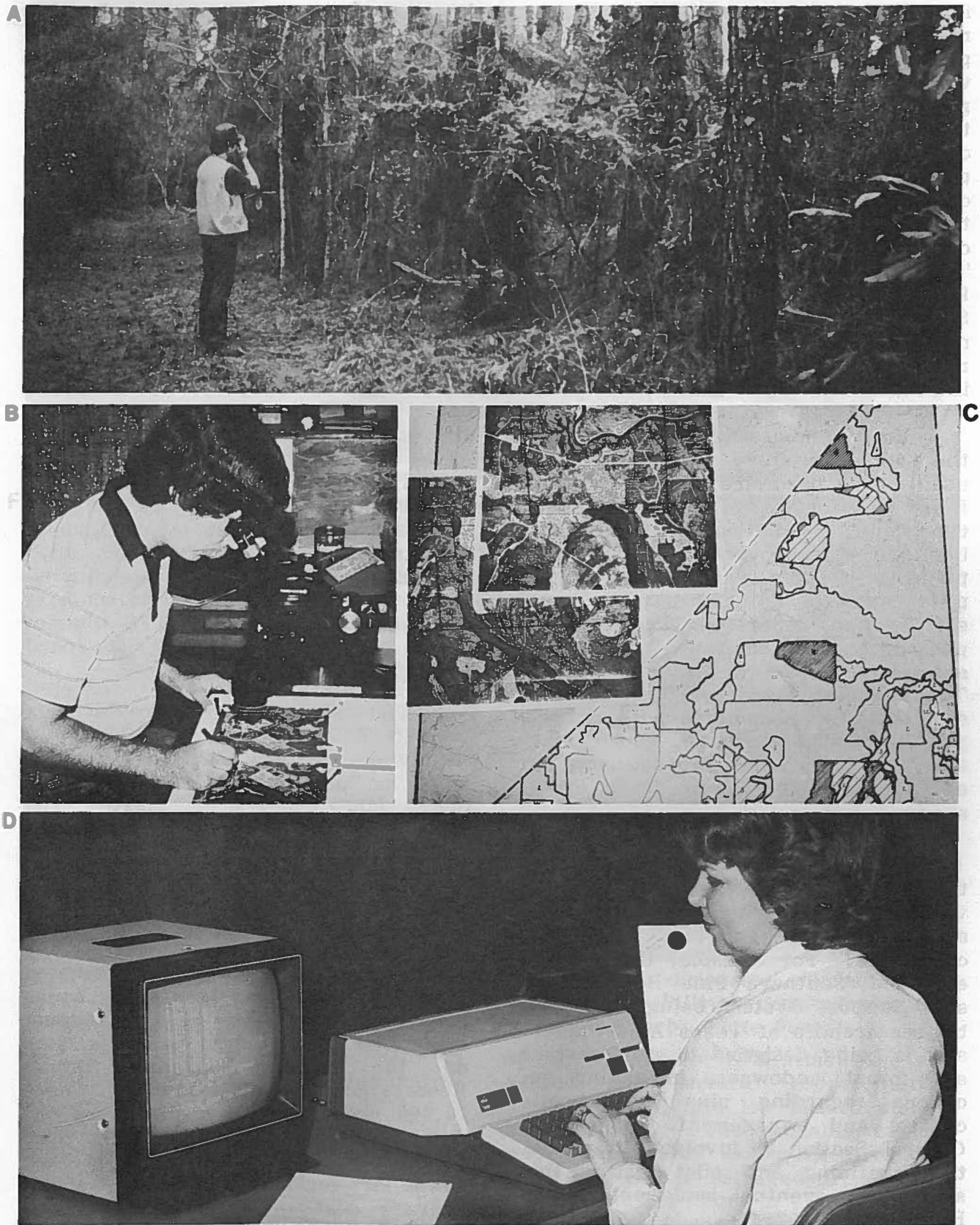


Figure 5. SPB demonstration project activities: A) high hazard pine stand in Polk County, B) project forester Charles Bryant records stand data for SPB hazard maps from color infra-red stereo photos, C) example of final SPB hazard map, D) Pest Control secretary Martha Johnson demonstrates Apple III microcomputer.

include interactive models to hazard rate pine stands for SPB infestations, predict SPB summer spot growth and timber losses, establish control priorities for SPB spots, and predict the number of SPB spots likely to occur in a given year. Other programs calculate the area in acres of any parcel of land and determine the value of individual shade or ornamental trees. In addition, the 'Integrated Pest Management Decision Key' developed by the USDA Forest Service to aid foresters and land managers in evaluating SPB, fusiform rust and annosus root rot problems, is programmed for the microcomputer.

Word processing capabilities of the microcomputer also have been used. The hardware (Escon Products Inc.) to interface an IBM Selectric II typewriter to the microcomputer was installed to provide letter quality printing. This has facilitated the preparation of letters, memos, manuscripts and reports. Pest Control personnel will continue to develop special programs of interest to the Texas Forest Service. As hardware and software compatible with an Apple III become available, those beneficial to forest and pest management assistance will be acquired and evaluated.

A computer terminal installed at the Pest Control Lab in Lufkin provides a means for accessing SPB models and programs from main-frame computers. For example, the computer-based 'Southern Pine Beetle Decision Support System' being developed by researchers at Texas A&M University is being designed to aid foresters and forest landowners in making decisions regarding pine bark beetle control and management. The Pest Control Section is involved in validating, refining and pilot testing this system for eventual implementation in East Texas.

Portable Sawmill

The uncertainty of a market has

been a deterrent for the effective utilization of beetle-killed timber, particularly on non-industrial private lands. To improve the utilization of downed and beetle-killed timber, the Pest Control Section has purchased and assembled a portable sawmill for use in the demonstration area (Figure 5E). The portable sawmill, or "Mobile Dimension Saw", represents a novel approach to timber utilization. The mill, mounted on a 22-foot trailer, can be moved from site to site with a 1-ton pickup to cut pine logs that have little market value. The log is held stationary on the trailer while the saw, powered by a small gas-powered engine, travels over the log. One or two boards of dimension lumber up to 4" x 12" are cut and edged simultaneously with each pass of the saw. The mill can be operated by one person, although 3-5 people are usually on hand to help load logs and stack lumber. Board size can be adjusted by the sawyer on each cut to minimize waste. On a good day, TFS District crews can produce 2,000-2,500 board feet of lumber.

The sawmill, together with a trained TFS operator from District 9 in Livingston, has been available for lease to Polk and Tyler county residents since September 1981. The sawmill is intended to be used primarily to salvage beetle-killed trees or to aid in thinning operations to reduce the susceptibility of pine stands to bark beetles. Landowners who lease the mill find a variety of uses for the rough-cut lumber, including fences, farm buildings, bridges and house construction. One of the biggest lease jobs completed to date was done on the Alabama-Coushatta Indian Reservation near Woodville, where 14,000 board feet of lumber were cut from ips-killed trees. So far, over 40,000 board feet of lumber have been sawn for various landowners, at an average cost of 8 cents per board foot.

Technology Transfer

Several demonstrations and

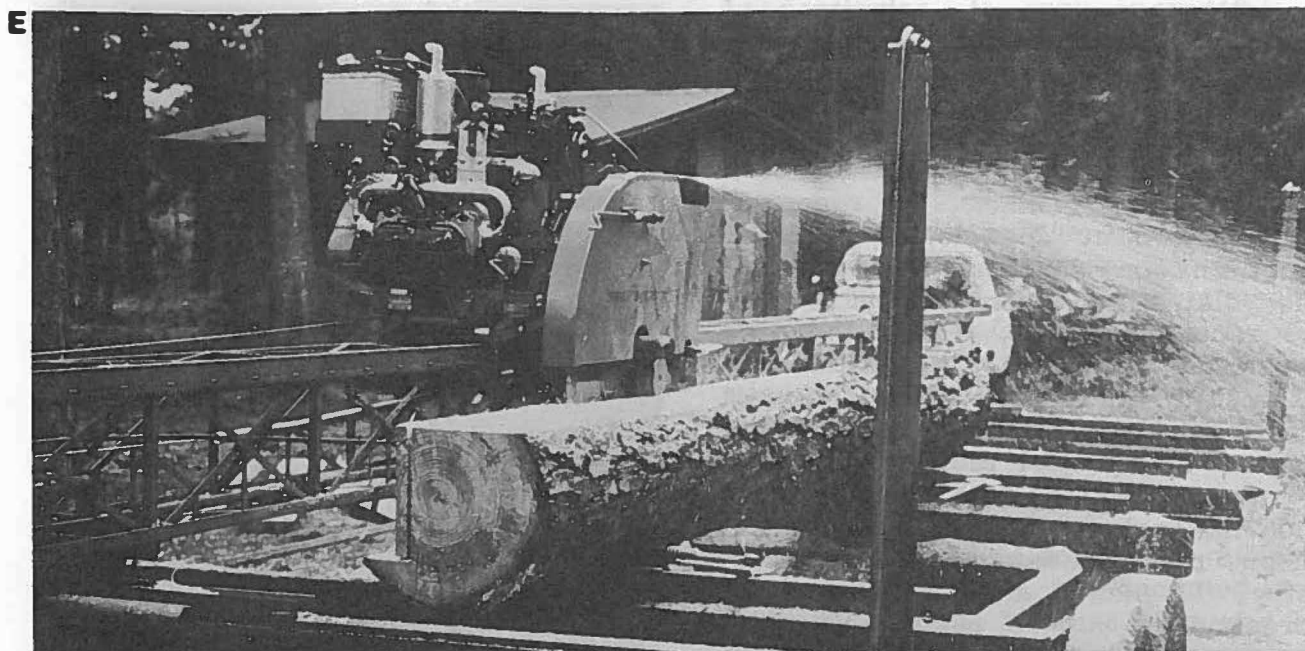


Figure 5. E) Portable sawmill produces rough-cut dimension lumber from beetle-killed pines, and F) principal entomologist Ron Billings demonstrates the portable sawmill as part of a landowner tour on the Kirby State Forest.

landowner tours have been held in conjunction with the SPB demonstration project. A landowner tour and seminar was held at the Kirby State Forest on August 1, 1981. Pest Control personnel discussed major pests of pine in East Texas and how to best control or prevent outbreaks of these pests. Emphasis was placed on the control of pests, particularly bark beetles, through the effective management of vigorous, healthy stands. A simple method for the hazard rating

of pine stands for SPB attack was presented and several representative high, medium, and low hazard stands were toured. The portable sawmill was demonstrated as an effective way to utilize timber salvaged from beetle infestations or cut in thinnings to reduce stand hazard (Figure 5F).

The sawmill was demonstrated to the general public at the Folk Festival and parade in Livingston, TX (October 1981). A sawmill fact sheet describing leasing policy and procedures

was distributed at the festival. Several additional sawmill demonstrations were made to various professional and non-professional groups during the biennial period.

A project newsletter entitled "Spotlight on Southern Pine Beetle" was distributed periodically during the reported period. This one-page newsletter provides information to interested individuals on project accomplishments, activities, and plans. The project recieved additional news coverage from various local and national media, including television, radio, newspapers, Texas Forestry, TF News, and the Journal of Forestry.

The project is scheduled for several more years. Progress is expected to continue with the identification of high hazard stands and areas. Hazard reduction will aid in the prevention of bark beetle outbreaks such as the one experienced in East Texas during the 1970's. Demonstrations, training sessions, newsletters, and how-to booklets will continue to transfer new technology for the integrated management of southern pine bark beetle pests to foresters and landowners in and around the demonstration area.

AERIAL PHOTOGRAPHY PROJECT

As part of a federal-state cooperative project for southern pine beetle prevention, the Texas Forest Service has been taking stereo black and white aerial photographs over East Texas for the purpose of updating fifteen minute quadrangle maps. These maps form an integral part of the SPB detection and ground check program and are used in many other TFS District operations. The Pest Control Section is maintaining a cataloged library of all photo negatives. During 1980 and 1981, 100% stereo coverage was obtained for 26 quadrangles covering 4,212,000 acres. The 9" X 9" photographs are



Figure 6. Entomologist Joe Pase mans the TFS survey camera used in aerial photography missions.

taken at a scale of 1:15,840 (1 mile = 4 inches) using an aerial survey camera mounted in the TFS DeHavilland Beaver aircraft (Figure 6). Each photograph covers an area of approximately 3240 acres.

In September 1980, a TDL-711 Loran-C Micro-Navigator® (Teledyne Systems Company) system was installed in the TFS Beaver aircraft. As a navigational aid, the Loran-C unit will allow an aircraft to fly equidistant parallel flight lines -- ideal for aerial photography and pest surveys. In spite of certain limitations, the system has benefited pest surveys and aerial photography missions by reducing flight times and improving the quality of aerial photo coverage.

The goal of the aerial photography project is to continually update aerial photos and corresponding base maps on a seven year cycle. Prints of individual photo negatives in the TFS photo library are



Figure 7. Slash pine with multiple stems and cankers due to infection by fusiform rust.

available to individuals or companies for a nominal fee.

EAST TEXAS FUSIFORM RUST SURVEY 1980

Fusiform rust (*Cronartium quercuum* f. sp. *fusiforme*) is considered by most foresters and forest pathologists to be the most serious disease infecting southern pines (see front cover). It has been recognized as a severe problem on both slash and loblolly pines in the southeastern United States for many years. The incidence and geographical distribution of fusiform rust in the southeastern United States has gradually increased over the past 20 to 30 years and is considered a major problem in pine management.

The rust has its greatest impact in nurseries, seed orchards and young pine plantations. Slash pine,

in particular, is very susceptible to the disease. The disease produces a canker or gall on the stem and/or branches and may cause the tree to branch into multiple (and unusable) stems (Figure 7). The weakened branches or stem then become susceptible to wind and ice breakage. In some cases the disease may kill the tree. Fusiform rust usually reaches its maximum infection level by the time the trees are ten years old. In pine plantations, the only practical method of minimizing losses to rust is to prune infected branches or eliminate (thin) infected trees.

In the past, southwide fusiform rust surveys have not included data from East Texas because rust was not considered a threat in this portion of the southern pine range. Rust surveys conducted in East Texas by the Texas Forest Service in 1969 and by Texas A&M University in 1976 showed relatively low levels of rust infection. The highest infection levels were found on slash pine in southeast Texas.

From July to October 1980, Texas Forest Service and forest industry personnel (Champion International, International Paper Company, Kirby Forest Industries, St. Regis Paper Company, Temple-Eastex Forests, and Wirt Davis Estates) sampled 50 slash and 31 loblolly pine plantations in southeast Texas to determine the current incidence of fusiform rust. An attempt was made to identify site factors associated with severe or light infection levels.

The 1980 survey was conducted in Trinity, San Jacinto, Montgomery, Polk, Liberty, Tyler, Hardin, San Augustine, Jasper and Newton counties. Loblolly and slash pine plantations between the ages of three and eleven years were randomly chosen for sampling. Within each plantation an arbitrary starting point was selected, and 25 trees were tallied in each of five plots for a total of 125 trees. In most cases, the plots were located two chains apart along a

straight line. Within each plot the 25 trees nearest the plot center were examined for the presence of branch and/or stem galls. For each plantation the following information was recorded: location (TFS grid and county), owner, species of pine, age, average tree height, site index, acres in plantation, regeneration method, surface soil texture and observations concerning oaks in or adjacent to the plantation.

For all plots in the 1980 survey, loblolly pine averaged eight percent stem infections and 18% with stem and/or branch galls. The highest infection rate for loblolly pine was found in Newton County where 16% of the trees sampled had stem galls and 30% had stem and/or branch galls. For all plots slash pine averaged 32% with stem infections and 55% with stem and/or branch infections. Newton County showed the highest infection level for slash pine; 39% of the sampled trees had stem galls and 58% had stem and/or branch galls.

Results from all three surveys (1969, 1976, 1980) showed that Jasper, Newton, Tyler and Hardin counties have had the greatest fusiform rust problem on both slash and loblolly pine and that the number of trees infected with rust is increasing.¹

The 1969 survey tallied only stem galls and can be compared geographically with the 1980 survey in Tyler, Hardin, Jasper and Newton counties. The 1969 survey showed 19% of the slash pines sampled in these four counties to have stem galls, compared to 37.5% of the slash pines with stem galls in the 1980 survey.

Footnote 1: It is difficult to directly compare results from this survey with those of the two previous studies due to differences in geographical area, sample size, sample distribution and sampling methods, among other factors. Accordingly, the trends and comparisons made here should be interpreted with these limitations in mind.

Only selected counties in the 1976 survey can be compared with the 1980 survey. Also, infection levels in the 1976 vs. 1980 surveys reflect the presence of branch and/or stem galls. The following table shows apparent differences between the 1976 and 1980 surveys.

	SLASH		LOBLOLLY	
	(% of trees with stem or branch galls)		(% of trees with stem or branch galls)	
County	1976	1980	1976	1980
Hardin	28	49	--	--
Jasper	60	58	--	--
Newton	40	58	10	30
Polk	--	53	4	12
Tyler	--	55	4	19

At the present time, levels of rust infection in southeast Texas are high in most slash pine plantations and relatively low in most loblolly pine plantations. But, infection levels appear to be increasing markedly for both species. Slash pine exhibited increased infection levels in 1980 except in Jasper County where the infection rate appears to have remained largely unchanged since 1976.

For both slash and loblolly pine a comparison was made in 1980 between the most severely infected areas and the least infected areas to determine if level of infection might be related to certain site factors that were collected. The data analysis revealed no obvious differences related to site, however older plantations generally had higher infection levels than younger plantations.

The increasing incidence of fusiform rust in southeast Texas warrants consideration in forest management plans. It is recommended that only pine species that exhibit resistance to fusiform rust be planted in southeast Texas. Rust resistant species include shortleaf pine, longleaf pine, Texas sources of loblolly pine and selected families of slash pine.

TRAINING SESSIONS

An important responsibility of the Forest Pest Control Section is to provide training sessions in the prevention and control of insect and disease pests. During 1980 and 1981, a variety of training programs was offered to foresters and technicians with the Texas Forest Service and forest industry throughout East Texas (Table 2). Topics covered were identification, life cycles, evaluation, prevention and control of major forest pests, pesticide use and safety, noninfectious diseases, and research in progress (Figure 8).

RESEARCH IN PROGRESS

The Forest Pest Control Section conducts applied research on major pest problems. Principally, these include cone and seed insects in seed orchards and pine bark beetles.

CONE AND SEED INSECT RESEARCH

Blister Coneworm Pheromone

In southern pine seed orchards, seasonal flight periods of coneworm adults traditionally have been monitored with light traps. These traps collect a wide variety of nocturnal insects, only a few of which are pests. Traps baited with the sex pheromones of coneworm moths would provide a simple and more efficient means of detecting and selectively monitoring coneworms. In 1979, a study was initiated by the Pest Con-



Figure 8. Participants in a cone and seed insect identification workshop inspect displays in the Forest Pest Control Section library.

trol Section in cooperation with Dr. Wendell Roelofs, chemist with the New York Agricultural Experiment Station and Cornell University, to identify the sex pheromone(s) of the blister coneworm (*Dioryctria clarioralis*). Methods of rearing the blister coneworm in the laboratory on an artificial diet were developed as part of this study.

Laboratory studies revealed that the primary components of the blister coneworm female sex pheromone are (Z)-9-tetradecenyl acetate (Z9-14:Ac) and (E)-9-tetradecenyl acetate (E9-14:Ac) in a ratio of 88:12. In field tests conducted during 1980 and 1981, numerous male blister coneworm moths were captured in traps baited with synthetic formulations of these compounds (Figure 9). Low release rates (30 μ g/trap) of Z9-14:Ac caught more male moths than higher release

Table 2: Summary of forest insect and disease training sessions provided by Texas Forest Service (TFS) Forest Pest Control personnel during 1980 and 1981.

Date	Location	Audience	Subject	Instructors
April - May 1980 (6 sessions)	Linden, Henderson Lufkin, Woodville Kirbyville and Conroe, TX	TFS & forest Industry for- esters and technicians	Prevention and control of south- ern pine beetle and other pests	H. A. Pase III R. F. Billings
June 1980 - 1981	Jefferson, TX	Texas Forest Resource Shortcourse	Insect & disease pests	H. A. Pase III
Spring - Fall 1980 - 1981	Lufkin, TX	Forestry stu- dents-Stephen F. Austin State University	Southern pine beetle, seed orchard pests	H. A. Pase III R. S. Cameron
November 1980	Charleston, SC (sponsored by USDA Forest Service)	Geneticists, seed orchard managers, en- tomologists and forest managers	Seed and cone Insect Identifi- cation	R. S. Cameron
January 1981 (4 sessions)	Lufkin, TX Woodworth, LA Camden, AR	Members of Western Gulf Forest Tree Im- provement Program (WGFTIP)	Seed and cone Insects	R. S. Cameron
January 1981	Henderson, Woodville, TX	TFS, forest Industry & consulting foresters	Town ant control with methyl bromide	H. A. Pase III
May 1981	Jasper, TX	Contact men (WGFTIP)	Seed & cone Insects, research	R. S. Cameron
August 1981	Kirby State Forest Warren, TX	Area landowners	Insect & disease prevention & control	R. F. Billings C. M. Bryant H. A. Pase III
Aug - Oct 1981 (5 sessions)	Linden, Henderson Lufkin, Woodville and Conroe, TX	TFS, forest Industry for- esters & tech- nicians	Insect and disease prevention and control	R. S. Cameron H. A. Pase III

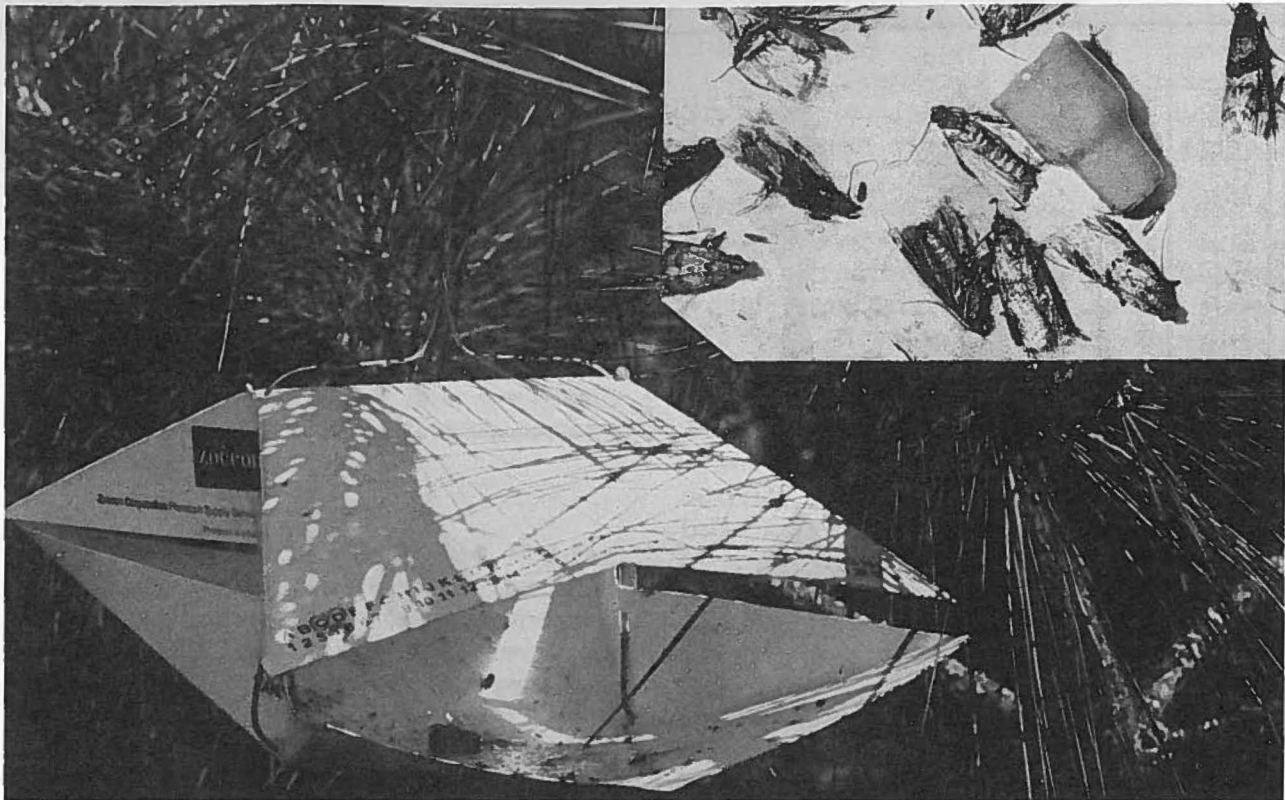


Figure 9. Pherocon 1 C® pheromone trap suspended in a loblolly pine tree and male blister coneworm moths caught in sticky adhesive in the bottom of the trap. Note the rubber septum containing synthetic sex pheromone (insert).

rates. Results of laboratory and field tests suggest that the pheromone produced by female moths contains other secondary pheromone components that remain to be identified.

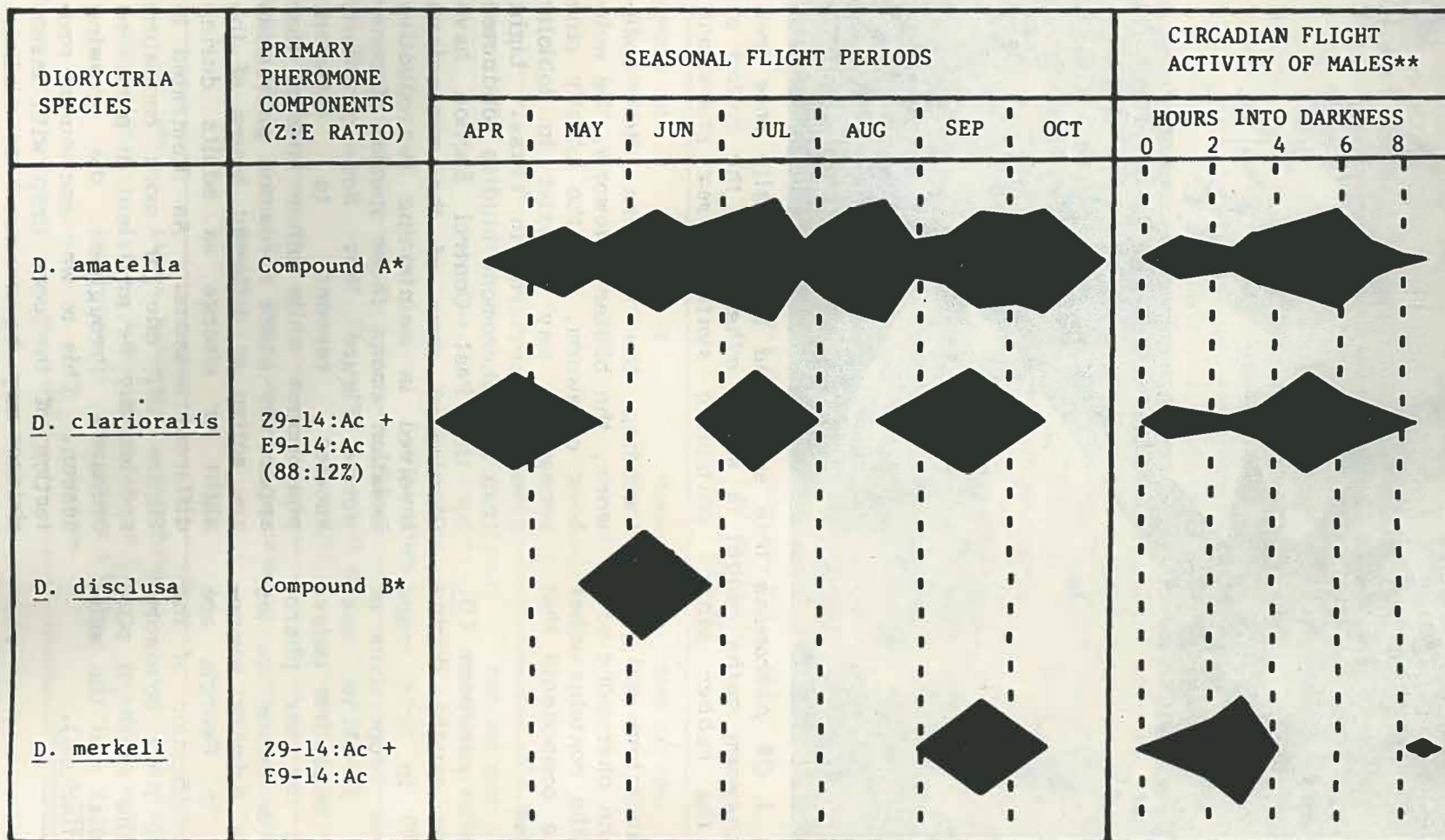
Many loblolly pine coneworm (*D. merkei*) males were caught during late summer in 1980 in field traps baited with the same proportions of synthetic Z- and E9-14:Ac most attractive to blister coneworm males. This indicates that the sex pheromones of these two coneworm species may have the same primary components. Scientists in Georgia are working on the identification of the sex pheromones of other coneworm species, including the southern pine coneworm (*D. amatella*) and the webbing coneworm (*D. disclusa*).

Reproductive Isolation of Coneworm Species

Several species of coneworms,

including the southern pine coneworm, the blister coneworm, the webbing coneworm, and the loblolly pine coneworm, may co-exist in loblolly pine seed orchards in Texas. Light trap and pheromone studies conducted by the Pest Control Section have illuminated some of the mechanisms involved in maintaining reproductive isolation among these species of coneworms (Figure 10). Some coneworm species respond to different pheromones while other species that apparently share a common pheromone are active at different hours of the night or emerge as adults during different seasons. As illustrated in Figure 10, one or more coneworm species may be prevalent in pine seed orchards throughout the growing season. This is why continuous protection of the cone crop with insecticides may be required to minimize losses to coneworms.

Figure 10. Primary pheromone components, seasonal flight periods and circadian flight activity of four species of *Dioryctria* coneworm moths occurring in southern pine seed orchards in Texas (from Cameron 1981).



* Unpublished information from W. L. Meyer, A. S. Hill, A. Tamhankar, C. W. Berisford, R. S. Cameron, and W. L. Roelofs. Identification of the sex pheromones of *Dioryctria amatella*, *D. clarioralis* and *D. disclusa*. Presented at the Entomological Society of America National Meeting, Atlanta, Georgia, 1980.

** Males caught in light traps at hourly intervals on September 27-28, 1979, at Lufkin, Texas.

Timing of Insecticide Applications

Furadan and Guthion, two of the insecticides registered for use in southern pine seed orchards, sometimes have provided inadequate control of cone and seed insect pests. Failures of insecticide treatments often are attributed to poor coverage or improper timing of Guthion sprays or, in the case of Furadan, inadequate rainfall for proper translocation of this systemic insecticide from the soil to the crowns of seed orchard trees.

A study was conducted during 1981 in a loblolly pine seed orchard at Magnolia Springs to evaluate whether insect control could be improved by timing spray applications to seasonal periods when coneworms and seed bugs are known to deposit eggs. Treatments included: 1) Guthion 5X best - five hydraulic sprays with Guthion 2S (0.2% active ingredient) applied April 27, June 8, July 9, August 11 and September 19 (These dates were selected to coincide with seasonal oviposition periods of coneworms and seed bugs, as predicted from historical records), 2) Guthion 4X best - four sprays applied on the same dates as the first four of the five best sprays, 3) Guthion 4X worst - four sprays applied between predicted oviposition periods on May 18, June 22, July 23 and September 5, 4) Furadan early - 8 oz. of Furadan 10G per inch dbh incorporated into the soil with a John Deere Pow'r Till Seeder® on February 4, 5) Furadan late - applied on April 28, and 6) a check (no treatment). Each treatment was applied to one ramet from each of eight clones. Test trees were separated from each other by at least 60 ft. on all sides.

Conelet and cone survival, percent coneworm damage among harvested cones, losses of developing ovules in conelets and cones, and quality of seeds in cones were monitored on each test tree to evaluate the efficacy of the treatments.

For most of the factors monitored, there were significant differences ($p < 0.05$) between the Guthion and Furadan treatments, but not between the Furadan treatments and the check (Tables 3 and 4, Figure 11). Although seed survival for the 4X best Guthion treatment was significantly greater than that for the 4X worst treatment during early stages of cone development, no significant differences in survival among spray treatments prevailed at cone harvest. Accordingly, we conclude from this study that historical records of insect activity per se may be insufficient information for improving the timing of insecticide sprays.

For greater efficacy, insecticide sprays ideally should be timed to coincide with actual populations of key insect pests in the orchard to be treated, rather than timed solely to historical patterns of insect abundance. By monitoring the seasonal abundance of coneworms and seed bugs throughout the year, the number of spray applications also might be reduced during those seasons when pest populations are low. However, practical methods for monitoring seed orchard pests must first be developed before these latter approaches can be evaluated.

Pest Management in Pine Seed Orchards

The results of several years of research on cone and seed insects in Texas pine seed orchards are summarized in the doctorate dissertation of R. S. Cameron. Studies were conducted on the biologies and methods of monitoring populations of important seed orchard pests, particularly the shieldback pine seed bug (*Tetyra bipunctata*) and the blister coneworm (*Dioryctria clarioralis*). Caging experiments demonstrated that adults and nymphs of the shieldback pine seed bug caused the most damage to cones during September, just prior to cone harvest. Larvae of the blister

Table 3: Percent healthy and coneworm-damaged cones at cone harvest on trees receiving Guthion, Furadan, or no treatment in a loblolly pine seed orchard at Magnolia Springs, TX. 1981.

Treatments ¹	Percent coneworm-damaged cones ²	Percent healthy cones
Guthion 5 X best	1.5 a	94.1 a
Guthion 4 X best	1.4 a	93.3 a
Guthion 4 X worst	1.5 a	93.5 a
Furadan early (4 Feb. 1981)	12.7 b	83.8 b
Furadan late (28 Apr. 1981)	13.1 b	81.6 b
Check (no treatment)	16.9 b	77.7 b

¹ Refer to text for explanation of treatments.

² Means followed by the same letter do not differ significantly ($p>0.05$) according to Duncan's Multiple Range Test.

Table 4: Mortality of ovules and developing seeds in conelets and cones receiving Guthion, Furadan or no treatment in a loblolly pine seed orchard at Magnolia Springs, TX. 1981.

Treatments ^a	1982 Cone crop - conelets -	1981 Cone crop - cones -			Total losses of ovules & seeds
	Aborted ovules ^b	Aborted ovules	Seed bug - damaged seed	Empty seed	
Guthion 5 X best	31.6 a	43.5 a	4.4 a	15.3 ab	94.8 a
Guthion 4 X best	32.3 a	45.7 a	10.9 qb	21.0 c	109.9 a
Guthion 4 X worst	45.0 a	61.0 a	5.7 a	14.2 a	125.9 a
Furadan late (28 Apr. 81)	78.2 b	58.2 a	13.3 bc	15.4 ab	165.0 b
Furadan early (4 Feb. 81)	86.9 b	53.8 a	18.3 c	16.3 ab	175.3 bc
Check (no treatment)	96.0 b	81.7 b	13.1 bc	18.6 bc	209.4 c

^a Refer to text for explanation of treatments.

^b Means followed by the same letter do not differ significantly ($p>0.05$) according to Duncan's Multiple Range Test.

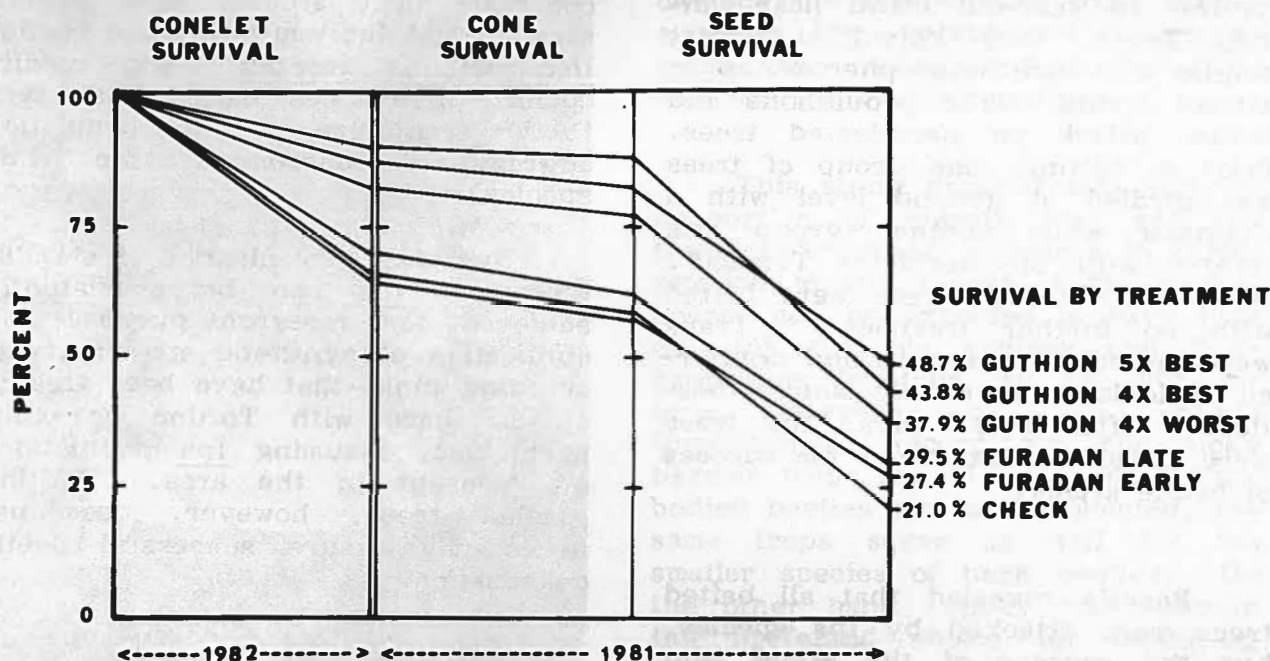


Figure 11. Conelet, cone and seed survival on trees receiving Guthion®, Furadan®, or no insecticide during 1981 in a loblolly pine seed orchard at Magnolia Springs, Texas (see text for explanation of treatments).

coneworm were found capable of causing substantial cone, conelet and terminal damage in loblolly pine seed orchards. Damage to cones is caused almost exclusively by larvae of the spring generation, which coincides with the time of rapid cone expansion. Larvae of the summer generation feed primarily on terminals and conelets.

Seasonal flight periods of the various cone- and seedworm species are described from light trap catches. As a result of a cooperative effort with chemists at Cornell University, the primary sex pheromone of the blister coneworm was identified and field tested in Texas seed orchards. Synthetic pheromone components attracted large numbers of male *D. clarioralis* moths as well as male moths of another coneworm, *D. merkei*. Results of these and other studies described in the dissertation should contribute to the eventual development of pest management programs for southern pine seed orchards.

BARK BEETLE RESEARCH

Our applied research efforts on bark beetles in recent years have focused primarily on engraver beetles (*Ips* spp.) due to the absence of southern pine beetle activity.

Baiting Pines to Induce *Ips* Attacks

In recent years, the population-aggregating pheromones or attractants for the three species of *Ips* engraver beetles have been isolated, identified and are now available in synthetic form for research purposes.

During 1979 and 1980, the Pest Control Section used a combination of synthetic attractants effective in aggregating all three *Ips* species in a tree-baiting study. The purpose of the study was to develop methods for predisposing standing trees to *Ips* infestation. Once developed, this technique would provide a means to further explore the attack behavior and food preferences of these bark beetles.

Individual loblolly pines in a natural 30 year-old stand near Lufkin, Texas, were baited at breast height with synthetic pheromones to attract flying beetle populations and induce attack on preselected trees. Prior to baiting, one group of trees was girdled at ground level with a chainsaw while another group was treated with the herbicide Tordon®. In a third group, trees were baited with no further treatment. Traps were placed on the trees and monitored periodically to sample landing beetles. After 14-21 days, the trees were felled and examined for success of beetle attack.

Results revealed that all baited trees were attacked by Ips species, but the success of the attack and level of beetle colonization varied markedly among treatments and between years. In tests conducted from June 27 - July 11, 1979 (summer treatment), trees treated by girdling or herbicide application were successfully colonized by Ips within 14 days. Although the girdled trees were killed, only the lower third of the bole was colonized, compared to 90% of the bole in herbicide-treated trees. Interestingly, baited trees that received no weakening treatment were visited by similar numbers of beetles, but all attacks were "pitched out" and the trees survived.

When these tests were repeated from May 14 - June 4, 1980 (spring treatment), only the herbicide-baited trees were successfully attacked by Ips within 21 days. The girdled as well as the check-baited trees resisted beetle attacks and survived.

Although exploratory, these studies provided evidence that healthy loblolly pine trees can successfully resist attacks by endemic populations of engraver beetles, even in the presence of synthetic pheromones. If pines are severely weakened, as simulated in these tests by herbicide treatment, they become host

material for engraver beetles. (In contrast, past studies have demonstrated that the southern pine beetle, Dendroctonus frontalis, will readily colonize live trees baited with synthetic frontalure - the population aggregating pheromone for this species).

Successful colonization of standing trees by Ips can be consistently achieved for research purposes by application of synthetic attractants to standing pines that have been treated at the base with Tordon or other herbicides, assuming Ips populations are present in the area. Baiting girdled trees, however, does not necessarily assure successful beetle colonization.

Evaluation of Bark Beetle Trap Designs

Pheromone traps which utilize barriers covered with sticky adhesive (sticky traps) have been used extensively for evaluating bark beetle behavioral chemicals. The sticky adhesive serves to snare insects landing on the trapping surface permitting field evaluation of the attractiveness or repellency of candidate chemicals. However, sticky traps have certain limitations. They are easily obstructed under forest conditions with debris and catch many non-target species. Handling of the traps and retrieval of captured insects is time-consuming and cumbersome.

We evaluated a variety of non-sticky trapping devices in an attempt to develop an alternative to sticky traps (Rose, et al. 1981).

The most practical trap we developed consisted of a non-sticky flight barrier made of polyethylene superimposed over a funnel collection device (Figure 12). This trap overcomes many of the disadvantages associated with the sticky trap previously used for bark beetle trapping studies.

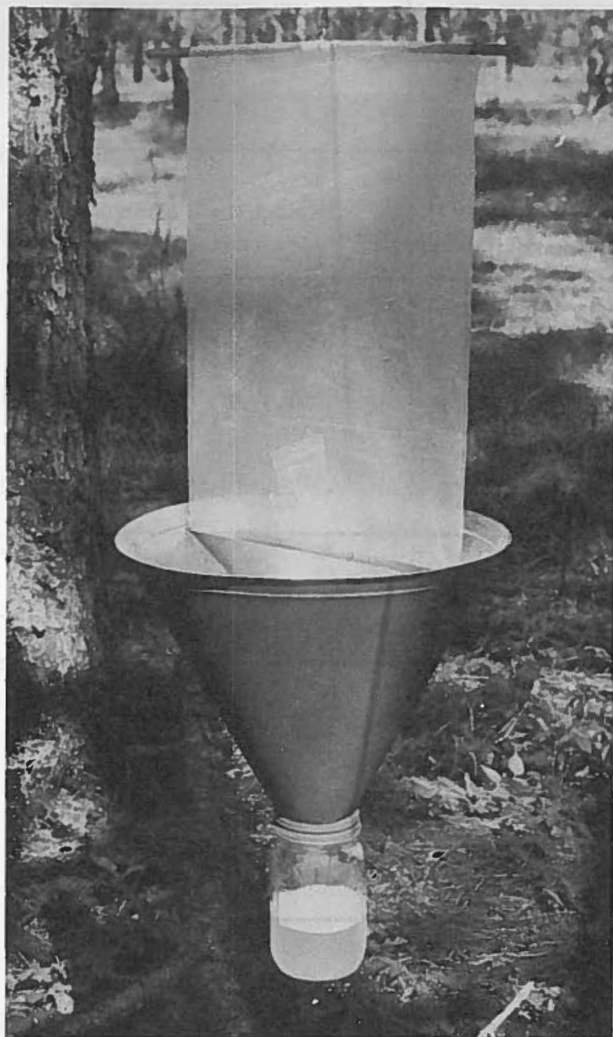


Figure 12. Funnel barrier trap developed for collecting pine bark beetles responding to pheromones.

In subsequent field tests, the trapping efficiency of this funnel barrier trap was compared to that of a 1/4" hardware cloth sticky panel of the same trapping surface area. To assess the potential for loss of insects from the sticky panel, we tested a third trap consisting of a sticky panel superimposed over a funnel collection device. In the latter case, insects collected from the sticky panel were recorded separately from those that fell from the sticky panel into the funnel below. Results (Table 5) revealed that our non-sticky funnel barrier trap is more efficient for trapping Ips calligraphus and other large bodied insects than are sticky traps. Indeed, pine sawyers (Monochamus spp.) may completely escape

capture with sticky traps. Trap catches for small-bodied bark beetles such as Ips avulsus and I. grandicollis were similar for both the sticky and non-sticky trap designs.

This study demonstrates that the proportion of insects that are lost from sticky traps increases in direct relation to the weight of the insect. Losses can be expected to vary from ca. 10% for Ips avulsus and Dendroctonus frontalis up to 100% for pine sawyers of the genus Monochamus. Accordingly, non-sticky barrier traps should be used if large bodied beetles are to be collected; the same traps serve as well for the smaller species of bark beetles. On the other hand, sticky traps remain the preferred choice for capturing small insects of the order Hymenoptera (wasps and parasites), Diptera (predatory flies) or Lepidoptera (moths). These light-bodied insects seldom are collected in non-sticky funnel barrier traps.

Pheromone Response by Bark Beetle Associates

The Pest Control Section conducted field studies in 1980 to monitor the response of Ips beetles and certain associated insects to funnel barrier traps (Figure 12) baited with various combinations of synthetic bark beetle pheromones. Traps were set up in a loblolly pine forest near Lufkin and the tests were replicated in the TFS pine seed orchard near Jasper. We tested the following baits simultaneously: 1) SPB attractants, 2) SPB inhibitors, 3) Ips attractants, 4) SPB attractants + SPB inhibitors, 5) Ips attractants + SPB inhibitors, and 6) host volatiles.

Our studies demonstrated that the clerid predator Thanasimus dubius (commonly known as checkered beetles) responds in greater numbers to baits containing frontalin, the aggregating pheromone of the southern pine beetle, than to baits containing

Table 5: Comparison of mean daily trap catches of selected beetle species on sticky and non-sticky traps and evaluation of loss of insects from sticky barriers.

Trap	Number of replications (days)	<i>Ips</i> <i>avulsus</i>	<i>Ips</i> <i>grandicollis</i>	<i>Ips</i> <i>calligraphus</i>	<i>Temnochila</i> <i>virescens</i>	<i>Monochamus</i> sp.
----- beetles/day -----						
A Non-sticky barrier	6	27.3	89.1	73.0	1.3	1.7
B Sticky barrier	6	30.0	92.0	23.8	0.3	0.2

% Efficiency of non- sticky trap ((A/B) x 100%)		91%	97%	307%	433%	850%

Test 2 ----- beetles/day -----						
C Funnel under sticky barrier**	6	3.7	11.3	21.0	0.2	2.5
D Sticky barrier over funnel	6	34.0	92.0	23.8	0.3	0

% Loss from sticky trap ((C/ C+D) x 100%)		10%	13%	45%	60%	100%

Oven - dry weight (gm) ($\pm$ S.D.)		0.55 $\pm$ 0.032	1.41 $\pm$ 0.113	3.54 $\pm$ 0.382	31.8 $\pm$ 14.93	219.8 $\pm$ 49.05

* Replicate = sum of two identical traps tested for 1 day.

** Trap catches in funnel represent insects lost from sticky barrier positioned above funnel collecting device.

Ips attractants (Figure 13). Measurable, but significantly fewer, numbers of clerids were caught on traps baited with a combination of ipsdienol, ipsenol and cis-verbenol -- pheromones attractive to all three species of *Ips* engraver beetles. In contrast, we found that the predator, *Temnochila virescens*, as well as pine sawyers of the genus *Monochamus*, responded almost exclusively to traps baited with the *Ips* pheromone mixture and not to traps baited with SPB pheromone. This is the first report of sawyer beetles utilizing

beetle-produced attractants as a means to locate suitable host material.

The addition of the SPB inhibitors brevicomin and verbenone to traps baited with SPB attractants or *Ips* attractants substantially reduced trap catches of checkered beetles and *Ips avulsus* but did not adversely affect the relative responses of *T. virescens*, *Monochamus* sp., *I. grandicollis*, or *I. calligraphus*. These response preferences help to explain the observed sequence of arrival and spatial patterns of colonization of these insect associates in

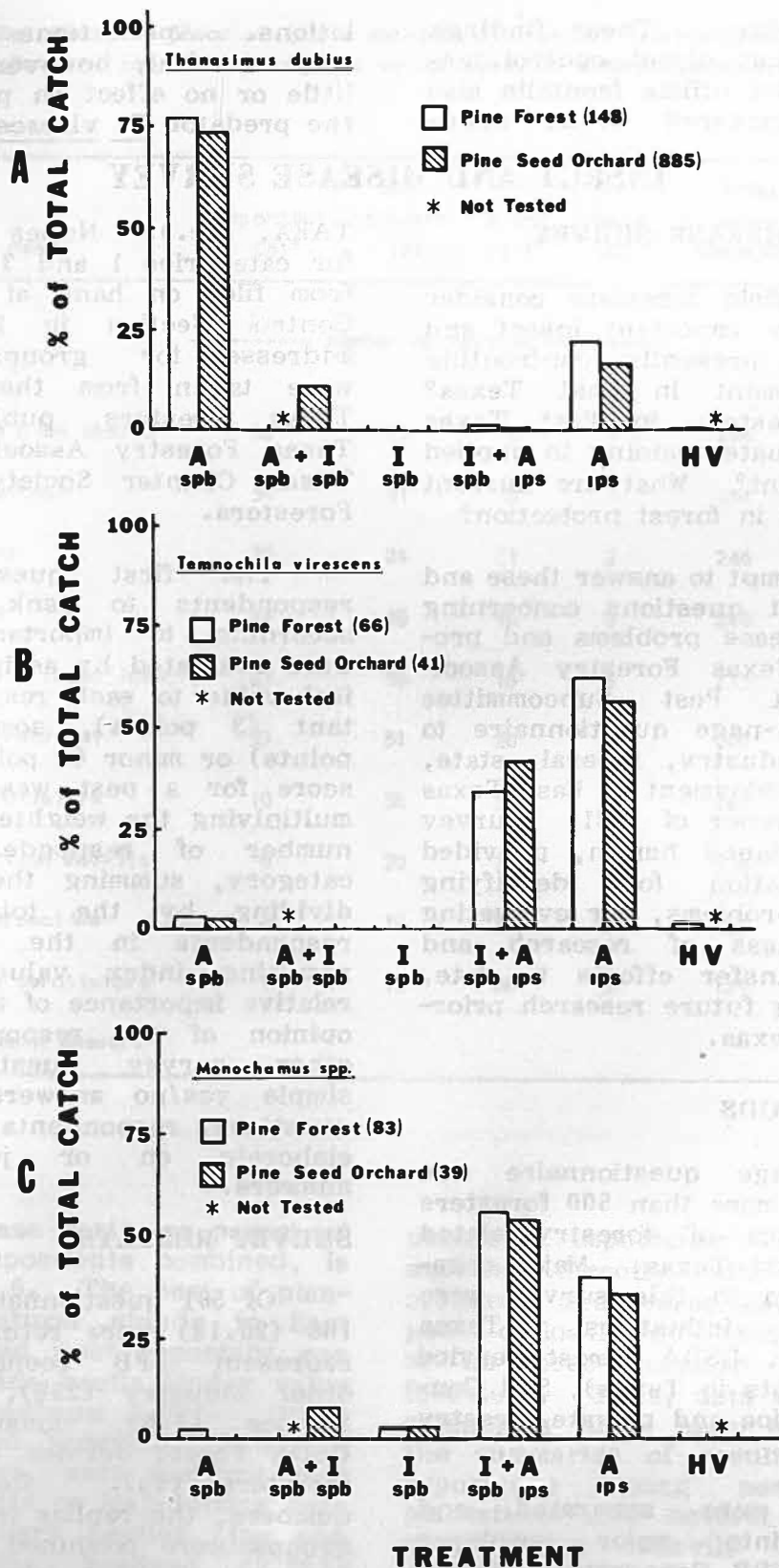


Figure 13. Field responses of *Thanasimus dubius* (A), *Temnochila virescens* (B) and sawyers of the genus *Monochamus* (C) to combinations of simultaneously - offered southern pine bark beetle pheromones. Aspb = southern pine beetle attractant (frontalure); Ispb = southern pine beetle inhibitors (brevicomin + verbenone); Aips = *Ips* attractants ((S)-cis-verbenol + ipsenol + ipsdienol). August - November 1981. Lufkin and Kirbyville, Texas.

SPB-infested pines. These findings also suggest that direct control tactics for SPB that utilize frontalins also will affect checkered beetle populations.

Applications of this behavioral chemical, however, should have little or no effect on pine sawyers or the predator T. virescens.

INSECT AND DISEASE SURVEY

INSECT AND DISEASE SURVEY

What do field foresters consider to be the more important insect and disease pests presently confronting forest management in East Texas? Are field foresters in East Texas receiving adequate training in applied pest management? What are current research needs in forest protection?

In an attempt to answer these and other pertinent questions concerning insect and disease problems and programs, the Texas Forestry Association's Forest Pest Subcommittee circulated a 2-page questionnaire to foresters in industry, federal, state, and private employment in East Texas during the summer of 1981. Survey findings, published herein, provided useful information for identifying current pest problems, for evaluating the effectiveness of research and technology transfer efforts to date, and for setting future research priorities in East Texas.

SURVEY METHODS

A two-page questionnaire was distributed to more than 500 foresters and managers of forestry-related facilities in East Texas. Major organizations polled in this survey were forest-related industries, Texas Forest Service, USDA Forest Service (National Forests in Texas), Soil Conservation Service and private forestry consultants.

Replies were separated and categorized into major employee groups: 1) SPB Cooperators (forest industry contacts specifically responsible for southern pine beetle control operations); 2) other industry; 3) Texas Forest Service (TFS); 4) consulting foresters; 5) other non-industrial foresters (USFS, SCS,

TAEX, etc.). Names and addresses for categories 1 and 3 were obtained from files on hand at the TFS Pest Control Section in Lufkin. The addresses for groups 2, 4 and 5 were taken from the 1980 list of Texas foresters, published by the Texas Forestry Association and the Texas Chapter Society of American Foresters.

The first question required respondents to rank insect pests according to importance. Replies were evaluated by assigning a numerical value to each response: important (3 points), some concern (2 points) or minor (1 point). The total score for a pest was calculated by multiplying the weighted value by the number of respondents for each category, summing the scores, then dividing by the total number of respondents in the group. The resulting index value reflects the relative importance of that pest in the opinion of the respondents. Most other survey questions required simple yes/no answers. For some questions, respondents were asked to elaborate on or justify certain answers.

SURVEY RESULTS

Of 581 questionnaires mailed out, 106 (20.1%) were returned. Replies represent SPB cooperators (27%), other industry (29%), Texas Forest Service (24%), consultants (11%), USDA Forest Service (3%) and other foresters (6%). Because of low numbers, the replies from the latter 3 groups were combined in most cases for analysis and labelled as "other non-industrial foresters".

Relative Importance of Pests -- All Respondents Combined

The relative importance of various

Table 6: Relative Importance of Insect and disease problems in plantations and natural stands of East Texas, as perceived by field foresters (Number of replies = 106).

Rank	Pest	Important (3)*	Some concern (2)	Minor (1)	No reply (0)	Total score (Max=318)	Mean (Max=3.00)
----- number of replies -----							
1	Southern pine beetle	88	15	2	1	296	2.79
2	Fusiform rust	54	41	10	1	254	2.40
3	Town ants	59	24	21	2	246	2.32
4	Ips, BTB	44	46	16	0	240	2.26
5	Terminal & shoot insects	27	58	18	3	215	2.03
6	Annosus root rot	27	51	26	2	209	1.97
7	Pine defoliators	10	38	57	1	163	1.54
8	Reproduction weevils	9	20	71	6	138	1.30
9	Oak wilt/decline	6	18	79	3	133	1.25
10	Hardwood defoliators	1	16	86	3	121	1.14

* Weight given each answer.

insect and disease pests, as perceived by all 106 respondents combined, is given in Table 6. The pest of plantations and natural stands in East Texas considered most important was the southern pine beetle (index value = 2.79 of a maximum 3.00). Other pests considered important, listed in decreasing order, were fusiform rust (2.40), town ants or leaf-cutting ants (2.32), other bark beetles (*Ips* and black turpentine beetles) (2.26), terminal and shoot insects affecting young pines (2.03), and annosus root rot (1.97). These six pests accounted for 81% of all replies in the category of important pests.

Certain pests are known to be of

primary importance to foresters working directly with forest seed orchards and nurseries. But these pests of local significance are of little or no direct concern to most field foresters. Thus, data for these pest categories have been excluded from the summaries of results. Of least importance among pests affecting plantations and natural stands were reproduction weevils (1.30), oak wilt/decline (1.25) and hardwood defoliators (1.14). Space on the questionnaire was provided for respondents to list insects and disease pests other than those named in Table 6, but no additional pests emerged as important or worthy of mention.

Table 7: Relative importance of insect and disease pests in plantations and natural stands in relation to geographic region in East Texas, as perceived by field foresters.

Pest	North *		Central **		South ***	
	Mean score	Rank	Mean score	Rank	Mean score	Rank
Southern pine beetle	2.73	1	2.81	1	2.85	1
Fusiform rust	2.23	5	2.38	3,4	2.43	2
Town ants	2.27	4	2.59	2	2.15	4
Ips, BTB	2.18	6	2.38	3,4	2.19	3
Terminal and shoot insects	2.32	3	2.05	5,6	1.83	5
Annosus root rot	2.41	2	2.05	5,6	1.64	6
Pine defoliators	1.45	7	1.54	7	1.51	7
Reproduction weevils	1.27	8,9	1.27	8	1.32	8
Oak wilt/decline	1.27	8,9	1.16	9	1.17	9,10
Hardwood defoliators	1.23	10	1.03	10	1.17	9,10
Number of responses	22		37		47	

* North = Red River, Bowie, Franklin, Titus, Camp, Morris, Cass, Wood, Upshur, Marion, Gregg, Harrison, Van Zandt, Henderson, Smith, Rusk, Panola, Anderson, Cherokee Counties.
(TFS Area I, II; Districts 1-5)

** Central = Leon, Madison, Houston, Trinity, Angelina, Nacogdoches, San Augustine, Shelby, Sabine Counties.
(TFS Area III; Districts 6-8)

*** South = Polk, Tyler, Jasper, Newton, Hardin, Liberty, Orange, Jefferson, Chambers, Harris, Montgomery, San Jacinto, Walker, Waller, Grimes, Washington, Fayette Counties.
(TFS Area IV, V; Districts 9-14)

Relative Importance of Pests--By Geographical Region

Replies to the first question, concerning the relative importance of insect and disease pests, were catego-

rized by geographical region based on the major county of employment listed by each respondent (Table 7). For purposes of this analysis, East Texas was divided into 3 regions as indicated in Table 7. Results indicate that the southern pine beetle is

Table 8: Relative Importance of Insect and disease problems in plantations and natural stands of East Texas in relation to employer groups, as perceived by field foresters.

Pest	SPB cooperators		Other Industry		Texas Forest Service		Other non-Industry*	
	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
Southern pine beetle	2.93	1	2.80	1	2.52	1,2	2.91	1
Fusiform rust	2.55	3	2.43	2	2.36	3	2.18	3
Town ants	2.59	2	2.17	5	2.52	1,2	1.95	6
Ips, BTB	2.10	4	2.27	3	2.20	4	2.55	2
Terminal & shoot insects	2.07	5	2.20	4	1.76	6	2.05	4
Annosus root rot	1.83	6	2.10	6	1.96	5	2.00	5
Pine defoliators	1.62	7	1.57	8	1.48	7	1.45	7
Reproduction weevils	1.17	8	1.67	7	1.00	10	1.32	9
Oak wilt/ decline	1.03	10	1.27	9	1.36	8	1.41	8
Hardwood defoliators	1.07	9	1.20	10	1.04	9	1.27	10
Number of responses	29		30		25		22	

* Consultants, federal, and non-TFS state-agency foresters.

considered the number one pest in all regions of East Texas. This pest received the highest index value (2.85) in the southern counties and the lowest score (2.73) in the northern counties. Although the regional index values may not be significantly different statistically, the trend is consistent with the historical pattern of SPB outbreaks, which have been most concentrated in southeast Texas.

Interestingly, the top six pests were the same for all three regions, even though the relative order of importance (or ranking) varied among regions. The number 2 pest in the north was annosus root rot (2.41) while in the central counties it was town ants (2.59); in the southern counties fusiform rust (2.43) ranked second. These findings are in general agreement with the histor-

ical prevalence of these major pests in each region.

Relative Importance of Pests -- By Employer Group

The relative importance of specific pests by categories of employer groups is listed in Table 8. Again, southern pine beetle ranked at the top of the list for all groups polled. This pest received the highest rank (2.93) by the SPB cooperators -- that group of industry foresters that deals directly with SPB control operations. Among the employer groups, Texas Forest Service foresters ranked the southern pine beetle the lowest (2.52). This index value was the same as that given to town ants by TFS personnel. This lower index value may reflect 1) the large number of respondents from northeast Texas, where southern pine beetle has been less of a problem or 2) the opinions of new TFS foresters hired since 1977 who have had little direct exposure to SPB infestations.

The six pests with the highest index scores included the same pests for all employer groups, but their order of importance differed among these groups (Table 8). Town ants received a higher index score than fusiform rust by SPB cooperators and the Texas Forest Service, while Ips/BTB was considered more important by the consultant and other non-industrial forester groups.

Which Pest Will Be Most Important in the Next Decade?

When asked to predict the most important pest problem confronting forest managers in their organization during the next decade, the majority of respondents (70%) in all employee groups listed the southern pine beetle. Fusiform rust and other problems associated with pine plantations were the second most frequent answer.

Are You Receiving Adequate Support in Forest Entomology and Pathology?

Respondents were asked to evaluate the support available to them in the areas of 1) survey and prediction; 2) damage assessment; 3) control methods; 4) extension (identification of pest problems); and 5) prevention. The multiple choice answers available were 1) satisfactory; 2) marginal; or 3) inadequate. Although the relative level of satisfaction varied considerably among employer groups (Table 9), the data for all groups suggest that categories of "control methods" and "prevention" are areas in which the need for more support or training is greatest. In other words, most foresters feel they have adequate information or training for identifying pest problems and assessing damage but lack sufficient methods for prevention or direct control.

Which Organizations Provide You With Support in Forest Protection?

In East Texas, information or support for dealing with forest pest problems is available from a number of sources, specifically 1) the Texas Forest Service (Pest Control Section); 2) USDA Forest Service (State and Private Forestry and Southern Forest Experiment Station) 3) Stephen F. Austin State University (School of Forestry); 4) Texas A&M University (Departments of Entomology, Plant Sciences and Forest Science); and 5) Texas A&M Agricultural Extension Service. Foresters were asked to rate each of the above organizations based on the level of support or information received on pest problems. Available options were 1) majority of support; 2) some support; or 3) little or no support. Results by employer group are listed in Table 10. Clearly, the majority of support to field foresters in all employer groups (with the exception of USDA Forest Service foresters) is provided by the Texas Forest Service. This conclusion is understandable since the

Table 9: Response to the question: "How would you evaluate the support available to you in the following areas?"

Category	SPB cooperators			Other Industry			Texas Forest Service			Other non-Industry*		
	1**	2	3	1	2	3	1	2	3	1	2	3
Survey and prediction	62%	28%	10%	63%	30%	7%	91%	9%	0%	77%	18%	5%
Damage assessment	61%	39%	0%	67%	33%	0%	77%	23%	0%	62%	24%	14%
Control methods	46%	36%	18%	27%	40%	33%	48%	48%	4%	40%	20%	40%
Extension	68%	25%	7%	64%	29%	7%	83%	17%	0%	80%	15%	5%
Prevention	21%	61%	18%	24%	52%	24%	52%	35%	13%	29%	29%	42%

* Consultants, federal, and non-TFS state-agency foresters.

** 1 = Satisfactory, 2 = Marginal, 3 = Inadequate.

TFS, through its Pest Control Section in Lufkin, has the direct responsibility for providing training and distributing information on pest problems to TFS, industry, and consulting foresters throughout East Texas. Among the other possible sources of information, field foresters are receiving some additional information from each of the other support organizations.

What are Research Needs on Forest Insects and Diseases?

Foresters were asked to specify areas in which forest insect and disease research could most benefit their operation. Of the replies received, the most common areas mentioned were 1) fusiform rust in nurseries and plantations; 2) other pests confronting plantation manage-

ment including town ants and tip moths; 3) southern pine beetle and other bark beetles; and 4) development of prevention or silvicultural control methods. Other frequently-mentioned needs were development of direct control methods for nursery pests and seed and cone insects; early detection of pest problems; and better methods for transferring available information to the field.

Are Large-scale Research Programs Beneficial?

The final question was, "As a client, do you feel that large-scale research programs, such as the USDA-sponsored Expanded Southern Pine Beetle Research and Applications Program (ESPBRAP), which focus money and manpower on a single pest problem, are beneficial?" A

Table 10: Response to the question: "To what extent does each of the following organizations provide you with support (or pertinent information) for dealing with major pest problems?"

Source of pest information	SPB cooperators			Other industry			Texas Forest Service			Other non-Industry*		
	1	2	3	1	2	3	1	2	3	1	2	3
USDA Forest Service (S&PF; Southern Exp. Sta.)	3%	42%	55%	7%	62%	31%	13%	48%	39%	27%	46%	27%
Texas Forest Service (Forest Pest Control Sect.)	93%	7%	0%	80%	17%	3%	100%	0%	0%	68%	32%	0%
Stephen F. Austin State University	0%	59%	41%	7%	57%	37%	4%	39%	57%	10%	33%	57%
Texas Agricultural Extension Service	0%	41%	59%	3%	24%	73%	9%	30%	61%	5%	52%	43%
Texas A&M University (Entomology, Forestry, Plant Sciences)	4%	48%	48%	14%	52%	34%	9%	48%	43%	5%	35%	60%

* Consultants, federal, and non-TFS state-agency foresters.

** 1 = Majority of support, 2 = Some support, 3 = Little or no support.

summary of replies by employer group is given on Table 11. The majority of respondents in each employer group gave affirmative replies. Interestingly, the group that provided the largest proportion of negative replies was the SPB Cooperators (35%), the group of industrial foresters that has been most closely associated with the SPB problem in the past.

Among those foresters in favor, most reasoned that a coordinated, multi-organizational effort such as that provided by ESPBRAP is warranted for a pest of the magnitude of the southern pine beetle. Many, however, felt such a large scale effort

would not be justified for most other pests.

Many foresters that gave negative replies were unconvinced that the ESPBRAP program had provided sufficient new information or solutions to the problem. Or if new technology had been developed, they felt it had yet to be implemented at the field level.

SURVEY CONCLUSIONS

The questionnaire provided useful feedback from field foresters in a variety of organizations throughout East Texas which should be useful for

Table 11: Response to the question: "As a client, do you feel that the large-scale research programs, such as the Expanded Southern Pine Beetle Program, which focus money and manpower on a single pest problem, are beneficial?"

Answer	SPB cooperators	Other Industry	Texas Forest Service	Other non-Industry*
Yes	48%	80%	84%	68%
No	35%	7%	0%	27%
No Reply	17%	13%	16%	5%

* Consultants, federal, and non-TFS state-agency foresters.

identifying the relative importance of pests, insect and disease training needs, and future research priorities.

Among the conclusions supported by this questionnaire are the following:

Despite the fact that southern pine beetle activity has been low throughout East Texas since 1977, field foresters rate this bark beetle as the number one pest.

Other pests considered important are fusiform rust (particularly in southern counties), town ants (particularly in central East Texas) and annosus root rot (particularly in northeastern counties.) Other bark beetles (Ips/BTB) and pine terminal and shoot insects (tip moths) also were considered among the top six pests by all employer groups.

Most foresters in all employer groups predict the most important pest problem in the next decade will be the southern pine beetle. Many foresters also anticipate increasing problems with fusiform rust and other pests of pine plantations.

Although most foresters feel they are receiving adequate training in applied pest management, there is need for more technical support in the areas of direct control and prevention methods.

The Texas Forest Service provides the majority of support and/or information to state and industry foresters in East Texas for dealing with pest problems.

Insect and disease research needs as specified by foresters are predominately in the areas of prevention and control of pine plantation pests (fusiform rust, town ants, tip moths) and pine bark beetles.

Most respondents agree that large-scale research programs directed at a single pest are beneficial if the pest is of sufficient importance, such as the southern pine beetle. With regard to new SPB technology now available as a result of region-wide research and application programs, certain foresters have witnessed little evidence of field implementation.

Finally, the fact that only 20 percent of the foresters on the mailing list returned the questionnaire is worthy of note. The low level of response may reflect a general lack of concern for forest pest problems among the majority of Texas foresters. If such is the case, there remains considerable room for improvement in relating the importance of pest problems and pest management philosophies to this group. Nevertheless, the consistency of replies among employer groups

suggests that the questionnaires returned provide an adequate sample of Texas foresters and that the opinions expressed are representative.

SURVEY ACKNOWLEDGMENT

Appreciation is extended to Mr. Robert N. Larsh, Chairman, and other members of the Texas Forestry

Association Forest Pest Subcommittee for their valuable inputs into the design of the insect and disease questionnaire and the analysis of the results. The Forest Pest Subcommittee thanks those foresters who took the time and effort to fill out and return the questionnaire. Without their individual contributions, this survey would not have been possible.

PUBLICATIONS

The Forest Pest Control Section has published the following articles during the 1980-81 biennium.

Billings, R. F. 1980. "Cut-and leave" for control of southern pine beetle. *Forest Farmer* 39: 6-7, 18.

Billings, R. F. 1980. Direct control, p. 179-192. In "The Southern Pine Beetle", R. C. Thatcher, J. L. Searcy, J. E. Coster, and G. D. Hertel, eds. USDA Forest Service Technical Bulletin 1631. 267 pp.

Billings, R. F. 1980. Implementing new southern pine beetle technology in East Texas. *Proceedings Society of American Foresters National Convention*. Sept. 29, 1981. Orlando, FL.

Cameron, R. S. 1981. Toward insect pest management in southern pine seed orchards with emphasis on the biology of Tetyra bipunctata (Hem., Pentatomidae) and the pheromone of Dioryctria clarioralis (Lep., Pyralidae). *Texas Forest Service Publ.* 126. 149 pp.

Pase, H. A. 1981. Oak decline or oak wilt...What is happening to Texas oaks? *TF News*. Texas Forest Service. Vol. 60 (Winter): 6-7.

Rose III, W. F., R. F. Billings, and J. P. Vité. 1981. Southern pine bark beetles: evaluation of non-sticky pheromone trap designs for survey and research. *Southwestern Entomologist*. 6:1-9.

Texas Forest Service. 1981. Fusiform rust in East Texas. *Texas Forestry*. July 1981. p. 8, 10, 11.

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Texas Forest Service. 1981. Southern pine beetle - gone (temporarily), but not forgotten. *TF News*. Vol. 60 (Spring): 11-12.

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PEST CONTROL STAFF

The Forest Pest Control Section consists of the following staff members:

Dr. Ronald F. Billings
Principal Entomologist

Dr. R. Scott Cameron
Entomologist III

Mr. Herbert A. Pase III
Entomologist II

Mr. Charles M. Bryant
Forester

Mrs. Carol D. Riggs
Technician I

Mr. F. Alan Smith
Technician I

Mrs. Eva P. Fagala
Technician I

Mrs. Martha L. Johnson
Secretary

Mr. Michael J. Caughey
Seasonal Assistant

Mrs. Anita L. Weisinger
Seasonal Clerk.

Several staff changes occurred in the Section during the past two years. Dr. Barry G. Hynum, employed as Entomologist III in February 1978, resigned in August 1980 to join a computer firm in San Diego, California. In a cooperative arrangement with Freiberg University in Germany, Scott Cameron completed all the requirements for the Doctor of Science degree in forest entomology, with Dr. J. Pierre Vite as his major professor. The doctorate degree was awarded in August 1981. In September 1981, Scott was promoted to the position of Entomologist III.

Charles Bryant joined the Section as forester in September 1980 to assist with the federally-funded SPB

demonstration project. Charles has a Bachelor of Science degree in forest management and environmental management from Stephen F. Austin State University. He expects to soon complete the Master of Science degree in forestry at SFASU.

Carol Riggs began employment with the Section in September 1980, replacing Amy Nystrom as Technician I. Carol comes to us with a Bachelor of Science degree in biology from Arizona State University. She is involved primarily with cone and seed insect research, under the direction of Scott Cameron.